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Effects of the Safe Drinking Water Act Amendments of 1986 on Army Fixed Installation Water Treatment Plants

by
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The Safe Drinking Water Act (SDWA) of 1974 was the first Federal legislation requiring all public water systems, including those operated on U.S. Army installations, to comply with national standards for contaminants that may adversely affect public health. In 1986 Congress enacted amendments to SDWA that required the U.S. Environmental Protection Agency (USEPA) to regulate 83 specific contaminants and accelerate the timetable for establishing those regulations. USEPA responded by enacting a series of rules covering various categories of contaminants. Six of these rules had been finalized as of June 1991; several others had not.

This report summarizes the effects of the SDWA Amendments finalized as of June 1991 on Army fixed installation water treatment plants. Information on treatment processes that fulfill the new regulations is also reported. Additionally, relevant background on the rules not yet finalized is provided.

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The Safe Drinking Water Act (SDWA) of 1974 was the first Federal legislation requiring all public water systems, including those operated on U.S. Army installations, to comply with national standards for contaminants that may adversely affect public health. In 1986 Congress enacted amendments to SDWA that required the U.S. Environmental Protection Agency (USEPA) to regulate 83 specific contaminants and accelerate the timetable for establishing those regulations. USEPA responded by enacting a series of rules covering various categories of contaminants. Six of these rules had been finalized as of June 1991; several others had not.

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FOREWORD

This research was performed for the U.S. Army Engineering and Housing Support Center (USAEHSC) under Project 62720A896, "Environmental Quality Technology"; Work Unit NN-TN1, "Technology to Renovate Army Potable Water Infrastructure to Meet SDWA." The USAEHSC technical monitor is Malcolm E. McLeod, CEHSC-FU-S.

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1 INTRODUCTION

Background

The Safe Drinking Water Act (SDWA) of 1974 was the first Federal legislation on drinking water to affect all public water systems. The purpose of this Act is to benefit public health by reducing the risk of waterborne disease. The Act "established a program to require compliance with national drinking water standards for contaminants that may have an adverse effect on the health of persons."[1] Continuing research in the field of drinking water shows potentially dangerous contaminants present in water that, nevertheless, meets the standards of the original Safe Drinking Water Act. The presence of these contaminants was the impetus for the 1986 Amendments to the Safe Drinking Water Act. The U.S. Environmental Protection Agency (USEPA) is required by these amendments to increase and expand regulation of the drinking water industry through promulgation of specific rules in several areas:

- synthetic organic chemicals (such as pesticides)
- monitoring
- surface water filtration
- lead and corrosion control
- hazardous waste injection wells
- wellhead protection
- viral and bacterial contamination
- groundwater contamination.

Many fixed U.S. Army installations have their own water treatment plants and will be subject to new regulations. In order to comply with these new regulations, many treatment plants will have to change treatment processes, monitoring practices, and operation practices.

Objective

The objective of this work is to provide up-to-date information to installation Directorates of Engineering and Housing (DEHs) on the status of the new regulations of the SDWA Amendments of 1986 and their effects on fixed Army installations, and to provide information on water treatment processes that fulfill the new regulations.

Approach

The literature was surveyed to identify issues related to the SDWA Amendments that would affect Army fixed installations. Relevant information was organized to present an up-to-date review of drinking water regulations. Additionally, several Army installations were studied to determine their existing treatment capabilities and the likely effects of the new rules. Estimates of necessary improvements for

[1] Safe Drinking Water Act Amendments of 1986, Public Law 99-339, 1986.

these water systems were based on existing or anticipated best available technology (BAT) practices, and by the requirements of the 1986 SDWA Amendments.

The body of this report summarizes the format, definitions, and issues related to the SDWA Amendments; provides a brief discussion of all final, proposed, and anticipated rules; and highlights important issues of interest to Army water system managers. Appendixes A through G provide a detailed discussion of the six final rules published as of June 1991, and one "strawman" rule. Appendix H summarizes three actual case studies of Army installation water systems and a hypothetical "worst-case scenario." Appendix I includes the Army's estimate of the cost of compliance with the SDWA Admendments through 2000. Appendix J is a bibliography for further reading on the new rules, including citations from the Federal Register (FR) and Code of Federal Regulations (CFR).

Scope

Because the body of regulations discussed here is, as a whole, in a constant state of change, this report should be considered a "snapshot" of the subject regulatory environment as of June 1991. The most detailed discussion is devoted to those rules published by that date. Discussion of proposed and anticipated rules is also included, but it is necessarily less detailed and the observations presented may be subject to change.

Mode of Technology Transfer

This information should be incorporated into applicable Army Regulations, and into Technical Manual (TM) 5-660, *Operation of Water Supply and Treatment Facilities at Fixed Army Installations*, and TM 5-813-3, *Water Supply, Water Treatment.*

2 REGULATION FORMAT, DEFINITIONS, AND ISSUES

Background

The format of the SDWA Amendments of 1986 is complicated. Each water system must take many variables into account when determining its compliance requirements. First, the standards are divided into several different rules that are being finalized sequentially instead of simultaneously. Each rule is *not* independent of all others, so as new rules are promulgated, there will be effects on rules promulgated earlier. Second, there are many distinctions among water systems that will change the actual requirements of the new regulations for each class of system. (The details of these classifications are explained later in this chapter).

Congress required USEPA to accomplish two basic tasks to establish standards for contaminants in drinking water. First, USEPA must publish national primary drinking water regulations for a total of 85 contaminants specifically designated by Congress. Secondly, USEPA must publish a Drinking Water Priority List of contaminants that may have an adverse effect on public health, and regulate 25 contaminants off that list every 3 years thereafter. The 1991 version of the Drinking Water Priority List is shown in Table 1.

USEPA was allowed to make seven substitutions on the original Congressional list of 85, but those seven substitutions were to be listed on the Drinking Water Priority List and regulated in the first group of 25. Table 2 shows the current list of contaminants to be regulated under the Safe Drinking Water Act.

The USEPA is promulgating regulations for the initial 85 contaminants in the form of 11 rules. Six have been finalized, two has been formally proposed, and three are expected in the future. They are:

Finalized Rules

- Fluoride Rule
- Volatile Organic Chemicals (VOCs) Rule*
- Surface Water Treatment Rule (SWTR)
- Total Coliform Rule (TCR)
- Synthetic Organic Chemicals and Inorganic Chemicals—Phase II (SOCs and IOCs [II])
- Lead and Copper Rule

Proposed Rules

- Synthetic Organic Chemicals and Inorganic Chemicals—Phase V (SOCs and IOCs [V])
- Radionuclides Rule

Upcoming Rules

- Disinfection/Disinfection Byproducts Rule (D/DBP)
- Groundwater Disinfection Rule (GWDR)
- Revised Arsenic Rule.

Each rule goes through four stages. Initially, there is an Advanced Notice of Proposed Rulemaking (ANPR). Following that are stages for rule proposal, finalization, and enforcement. Figure 1 shows the timetable for the final three steps: Proposed Rule, final rule, and Regulations Effective. Unless the rule is finalized, the dates shown are not fixed. Dates estimated by the USEPA are shown for reference.

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* Although the initialism "VOC" is commonly defined as "volatile organic *compound*" by environmental scientists and technicians, the new rules associated with the SDWA Amendments define VOC as "volatile organic *chemical*." This report uses the latter term for consistency with the USEPA language.

Table 1

Contaminants That May Require Regulation Under the Safe Drinking Water Act (1991 Priority List)

Inorganics	*Pesticides*	
Aluminum	Asulam	Metribuzin
Boron	Bentazon	Parathion degradation product
Chloramines	Bromacil	(4-Nitrophenol)
Chlorate	Cyanazine	Prometon
Chlorine	Cryomazine	2,4,5-T
Chlorine Dioxide	DCPA (and its acid	Thiodicarb
Chlorite	metabolites)	Trifluralin
Cyanogen Chloride	Dicamba	
Hypochlorite Ion	Ethylenethiourea	
Manganese	Fomesafen	
Molybdenum	Lactofen/Acifluorfen	
Strontium	Metalaxyl	*Microorganisms*
Vanadium	Methomyl	
Zinc	Metolachlor	Cryptosporidium
	Synthetic Organic Chemicals	
Acrylonitrile	Dibromoacetonitrile	Hexachlorobutadiene
Bromobenzene	Dibromochloromethane	Hexachloroethane
Bromochloroacetonitrile	Dibromomethane	Isophorone
Bromodichloromethane	Dichloroacetonitrile	Methyl ethyl ketone
Chlorination/Chloramination	1,3-Dichlorobenzene	Methyl isobutyl ketone
by-products (e.g.,	Dichlorodifluoromethane	Methyl-t-butyl ether
Haloacetic Acids,	1,1-Dichloroethane	Naphthalene
Haloketones, Chloral Hydrate,	2,2-Dichloropropane	Nitrobenzene
MX-2,	1,3-Dichloropropane	Ozone by-products, (e.g.,
N-Organochloramines)	1,1-Dichloropropene	Aldehydes, Epoxides,
Chloroethane	1,3-Dichloropropene	Peroxides, Nitrosamines,
Chloroform	2,4-Dinitrophenol	Bromate, Iodate)
Chloromethane	2,4-Dinitrotoluene	1,1,1,2-Tetrachloroethane
Chloropicrin	2,6-Dinitrotoluene	1,1,2,2-Tetrachloroethane
o-Chlorotoluene	1,2-Diphenylhydrazine	Tetrahydrofuran
p-Chlorotoluene	Fluorotrichloromethane	Trichloroacetonitrile
		1,2,3-Trichloropropane

Table 2

Contaminants To Be Regulated Under SDWA Amendments

Regulated Under NIPDWR	**Regulated Under Amended SDWA**
VOCs	
	Benzene (VOCs)
	Carbon Tetrachloride (VOCs)
	Chlorobenzenes (V)
	Monochlorobenzene (II)
	Dichlorobenzenes (II,PL)
	para-Dichlorobenzene (VOCs)
	ortho-Dichlorobenzene (II)
	1,2-Dichloroethane (VOCs)
	1,1-Dichloroethylene (VOCs)
	cis-1,2-Dichloroethylene (II)
	trans-1,2-Dichloroethylene(II)
	Methylene Chloride (Dichloromethane) (V)
	Tetrachloroethylene (Per-chloroethylene or PCE) (II)
	Trichlorobenzenes (V)
	1,1,1-Trichloroethane (VOCs)
	Trichloroethylene (Trichloroethene or TCE) (VOCs)
	Vinyl Chloride (VOCs)
Microbial	
Coliforms (TCR)	Giardia Lamblia (SWTR)
Turbidity (SWTR)	Legionella (SWTR)
	Standard Plate Count (SWTR)
	Viruses (SWTR)
Inorganics	
Arsenic (A)	Antimony (V)
Barium (II)	Asbestos (II)
Cadmium (II)	Beryllium (V)
Chromium (II)	Copper (LC)
Fluoride (F)	Cyanide (V)
Lead (LC)	Nickel (V)
Mercury (II)	Nitrite (II)
Nitrate as N (II)	Sulfate (V)
Selenium (II)	Thallium (V)
Silver*	
Sodium* & Corrosion (LC)	
Radionuclides	
Beta Particle/Photon radioactivity (RAD)	Radon (RAD)
Gross alpha particle activity (RAD)	Uranium (RAD)
Radium-226 plus Radium-228 (RAD)	

Table 2 (Cont'd)

Regulated Under NIPDWR	Regulated Under Amended SDWA
Organics	
2,4-D (II)	Acrylamide (II)
Endrin (V)	Adipates (V)
Lindane (II)	Alachlor (II)
Methoxychlor (II)	Aldicarb (II)
Toxaphene (II)	Aldicarb Sulfone (II)
2,4,5-TP (II)	Aldicarb Sulfoxide (II)
Trihalomethanes (DBP)	Atrazine (II)
	Carbofura (II)
	Chlordane (II)
	Dalapon (V)
	Dibromochloropropane (DBCP) (II)
	1,2-Dichloropropane (II)
	Dinoseb (V)
	Diquat (V)
	Endothall (V)
	Epichlorohydrin (II)
	Ethylene Dibromide (II)
	Glyphosphate (V)
	Heptachlor (II)
	Heptachlor epoxide (II)
	Hexachlorocyclopentadiene (V)
	Pentachlorophenol (II)
	Phthalates (V)
	Picloram (V)
	Polychlorinated biphenyl (PCB) (II)
	Polynuclear aromatic hydrocarbon (PAH) (V)
	Simazine (V)
	Styrene (II)
	2,3,7,8-Tetrachlorodibenzo-dioxin (dioxin) (V)
	Toluene (II)
	1,1,2-Trichloroethane (V)
	Vydate (Oxamyl) (V)
	Xylenes (total) (II)

KEY TO SYMBOLS

NIPDWR	-	National Interim Preliminary Drinking Water Regulations
VOCs	-	Volatile Organic Chemicals Rule
F	-	Fluoride Rule
SWTR	-	Surface Water Treatment Rule
TCR	-	Total Coliform Rule
II	-	Synthetic Organic & Inorganic Chemicals (Phase II)
V	-	Synthetic Organic & Inorganic Chemicals (Phase V)
LC	-	Lead and Copper Rule
RAD	-	Radionuclides Rule
DBP	-	Disinfection By-Products Rule
A	-	revised Arsenic Rule
PL	-	Priority List
*	-	Subsequently removed from Priority List

Water System Classifications

Each water system must be classified relative to several variables, including water source, water system type, population served, and vulnerability to contamination. The SDWA applies only to systems defined as "public water systems," so initially, a system must be defined as public or not public. A system is public if it has 15 or more service connections, or regularly serves at least 25 people for 60 or more days per year. Thus, most Army installation water systems will be considered public water systems. Range wells, which serve a large number of people for a short period of time, will be considered public water systems if the well serves the same 25 people for more than 60 days out of a year.

Water Source

The source water type is also important in deciding which regulations apply to which systems. There are basically three classifications: groundwater, groundwater under the influence of surface water, and surface water. In most instances, surface water and groundwater under the influence of surface water are regulated together.

Water System Type

After a system is determined to be a public water system, there are three categories into which it can fall. The flow chart in Figure 2 shows the specific divisions for each of the categories.

A public water system (PWS) has 15 or more service connections, or it regularly serves at least 25 people for 60 or more days per year. A community water system (CWS) has at least 15 service connections to permanent residents, or regularly serves at least 25 permanent residents (e.g., any residential area, or trailer park). A noncommunity nontransient water system (NCNTWS) regularly serves at least 25 of the same people over 6 months of the year (e.g., a school). A noncommunity transient water system (NCTWS) is any public water system which cannot be defined as a CWS or an NCNTWS (e.g., a highway rest stop or outdoor recreation area).

Population

Parts of the regulations are phased in on the basis of population size. There are four population categories: less than 25, 25-500, 500-3300, and greater than 3300. Usually, the smaller systems are given a longer time period within which to comply. Many monitoring requirements are also based on system population, but those divisions are made within each rule.

The Lead and Copper Rule uses population divisions of large (serves more than 50,000), medium (serves between 3300 and 50,000), and small (serves less than 3300).

Vulnerability to Contamination

Further divisions are made within each rule. Within the VOCs Rule, a system is determined to be "vulnerable" or "nonvulnerable" to contamination by VOCs. This distinction affects a system's compliance requirements. This classification is also used in other regulations addressing organic chemicals.

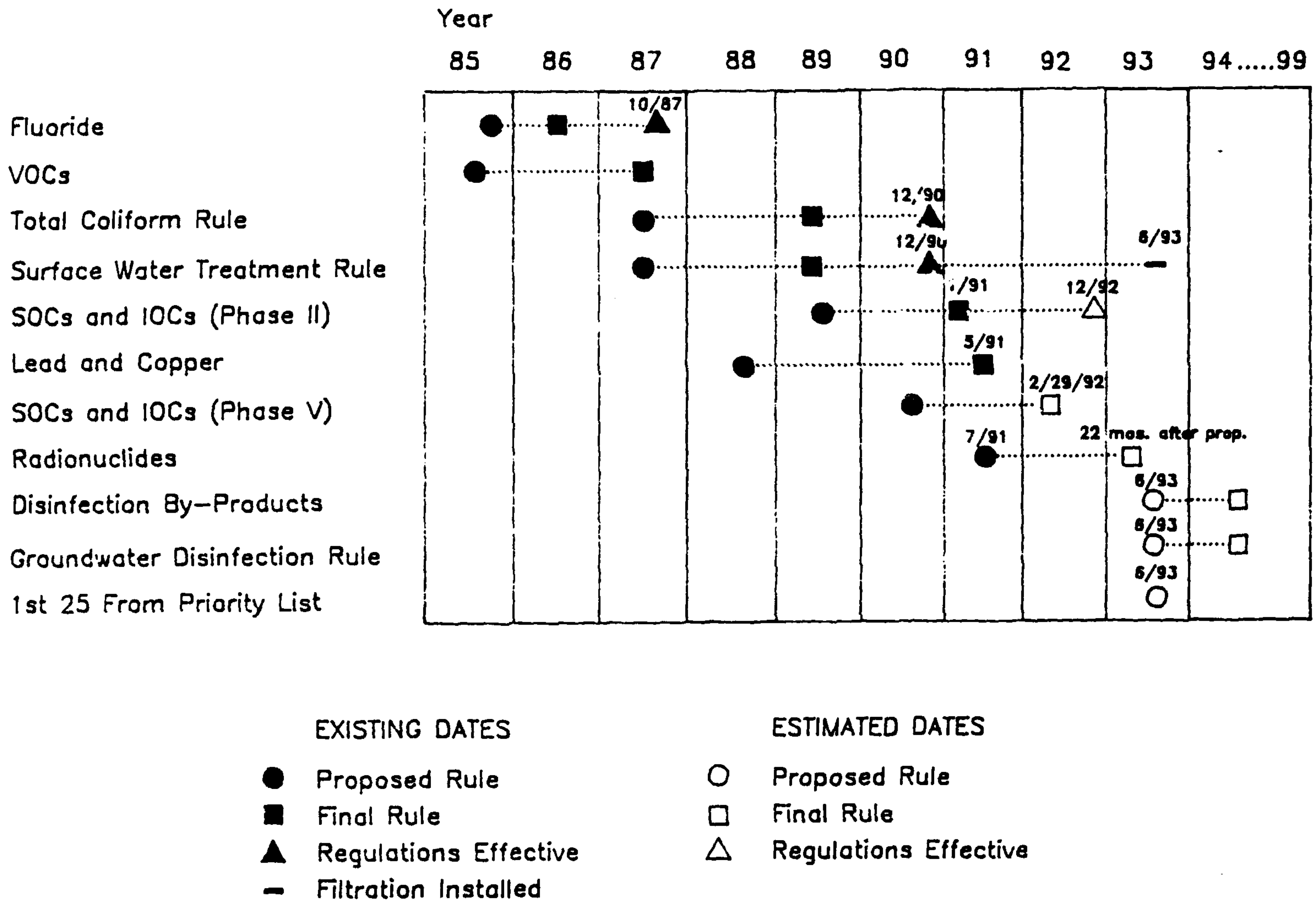

Figure 1. Regulatory Timetable as of June 1991.

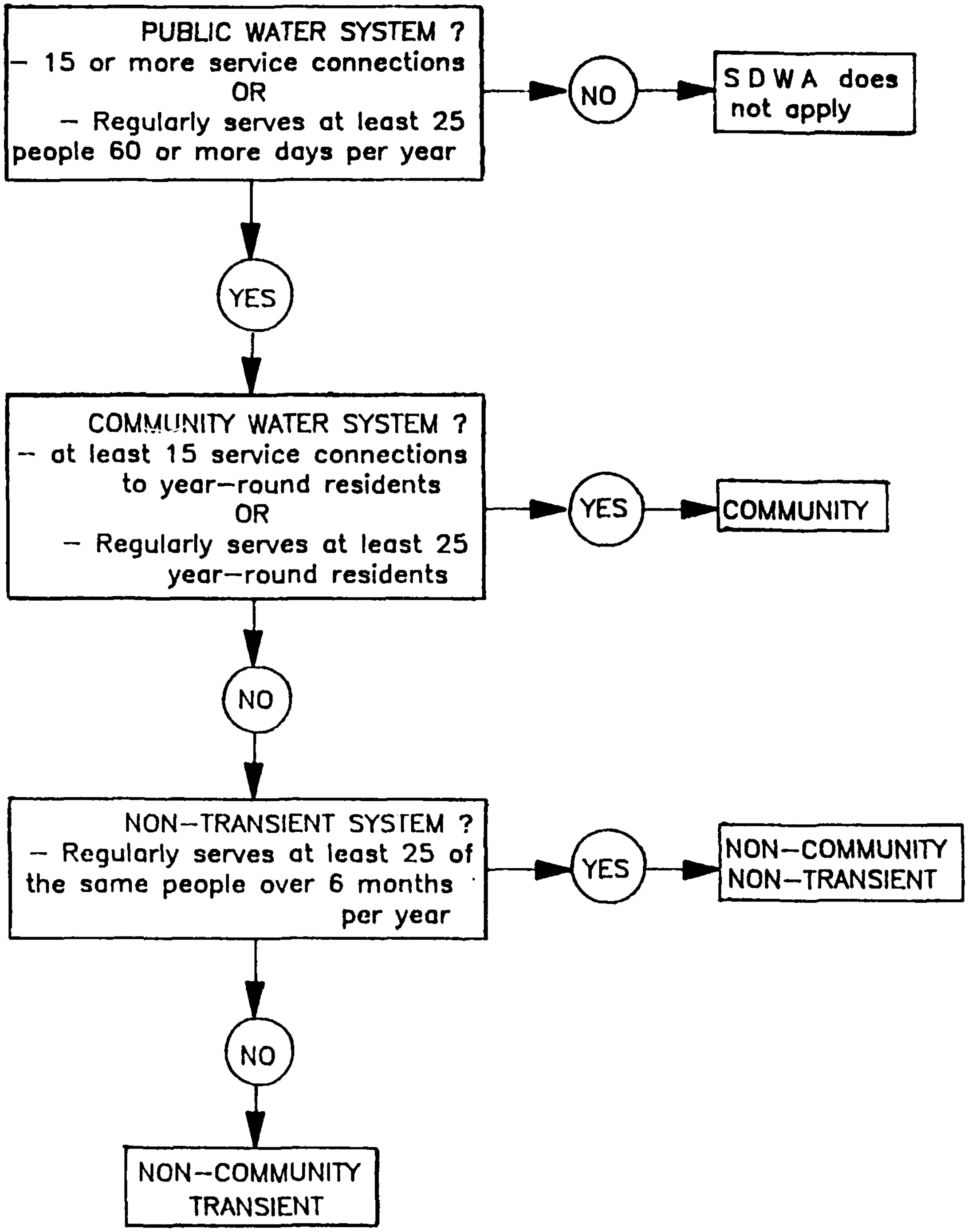

Figure 2. Water System Categories.

Classifications, Definitions, and Interpreting the New Rules

All of these categories of rules, system types, and populations mean that individual drinking water systems are subject to different dates of compliance and different requirements for compliance. Throughout this report, it will be important to recognize the differences among these classifications. For any particular system it will be useful to identify which classifications apply before attempting to interpret the requirements of the new regulations.

Best Available Technologies

USEPA provides a list of technologies, treatment techniques, and other means available to meet each regulation it promulgates. These technologies are designated Best Available Technology, or BAT.

Several factors determine the BAT for each contaminant. High removal efficiency, compatibility with other water treatment processes, availability, and affordability are a few of the factors considered. Before a technology can be designated as BAT, it must have been examined for efficiency under field conditions, not just laboratory conditions.

The BAT is the technology referenced when USEPA sets the MCLs. The SDWA requires that the MCL be set as close as possible to the MCLG "with the use of the best technology, treatment techniques, and other means the Administrator finds available (taking cost into consideration)." Therefore, the contaminant MCL is greatly affected by the technology available to remove that contaminant, because the MCL is set with cost of removal taken into consideration.

The BAT is the technology referenced when a PWS requests a variance. For a system to be granted a variance, the BAT must be installed.

If a system can meet an MCL without the use of BAT, the system is not required to install BAT.

Unlike the BAT for all other categories under SDWA, the BAT for SOCs was mandated by Congress, not USEPA. In this case, Congress designated granular activated carbon (GAC) as the BAT for synthetic organic chemicals. Any technology, treatment technique, or other means found by USEPA to be the best available for the control of SOCs must be at least as efficient as GAC. USEPA defines BATs for compounds other than synthetic organics.

Table 3 lists all BATs identified for each contaminant at this time.

Projected Army Safe Drinking Water Program Costs

In October 1991 the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) released the report *U.S. Army Cost of Compliance Projections: Background Summary of Assumptions and Methods*. This document was prepared as part of a larger report, *U.S. Army Report to Congress on Environmental Requirements and Priorities for 1991 to 2000*. The total cost of compliance between 1991 and 2000 was projected at $1.675 billion. The costs were broken down between compliance with existing and future regulations, operations and maintenance, planning and design, and capital improvement. Appendix I summarizes the assumptions and methodology used in the USATHAMA study, as well as annual cost projections through 2000.

Table 3

Current Best Available Technologies

	AAA	CLO	CON	CC	DF	DIF	ED	GAC	IE	LS	RO	PAP	PTA	UV
Mic'obial Contaminants														
Giardia			3log											
Viruses			4log											
Legionella			X											
HPC Bacteria			X											
Turbidity			X											
Coliforms			X											
Inorganic Contaminants <Phase II>														
Asbestos			X	X	X	X								
Barium							X		X	X	X			
Cadium			X						X	X	X			
Chromium III			X						X	X	X			
Chromium VI			X						X		X			
Mercury			X					X		X	X			
Nitrate							X		X		X			
Nitrate									X		X			
Selenium IV	X						X			X	X			
Selenium VI	X								X	X	X			
Fluoride	X													
Inorganic Chemicals <Proposed Phase V>														
Antimony			X								X			
Beryllium	X		X						X	X	X			
Cyanide		X							X		X			
Nickel									X	X	X			
Sulfate									X		X			
Thallium	X								X					
Volatile Organic Chemicals														
Benzene								X					X	
Carbon Tetrachloride								X					X	
para-Dichlorobenzene								X					X	
1,2-Dichloroethane								X					X	
1,1,1-Trichloroethane								X					X	
Trichloroethylene <TCE>								X					X	
Vinyl Chloride								X					X	
								X						
Synthetic Organic Chemicals <Phase II>														
Acylamide												X		
Alachlor								X						
Aldicarb								X						
Aldicarb Sulfone								X						
Aldicarb Sulfoxide								X						
Atrazine								X						
Carbofuran								X						
Chlordane								X			X			
2,4-D								X						
Dibromochloropropane													X	
ortho-Dichlorobenzene								X					X	
cis-1,2-Dichloroethylene								X					X	
trans-1,2-Dichloroethylene													X	
1,2-Diochloropropane													X	
Epichlorohydrin														

Table 3 (Cont'd)

	AAA	CLO	CON	CC	DF	DIF	ED	GAC	IE	LS	RO	PAP	PTA	UV
Ethylene Dibromide								X					X	
Ethylbenzene								X					X	
Heptachlor								X						
Heptachlor Epoxide								X						
Lindane								X						
Methoxychlor								X						
Monochlorobenzene								X					X	
PCBs								X						
Pentachlorophenol (PCP)								X						
Styrene								X					X	
2,4,5-TP (Silvex)								X						
Tetrachloroethylene								X					X	
Toluene								X					X	
Xylenes (total)								X					X	
(Proposed Phase V)														
Adipates <Di(ethylhexyl)adipate>								X					X	
Benzo(a)pyrene														
Dalapon								X						
Dichloromethane (Methylene													X	
Chloride)								X						
Dinoseb								X						
Diquat								X						
Endothall								X						
Endrin								X						
Glyphosphate								X						
Hexachlorobenzene								X					X	
Hexachlorocyclopentadiene (HEX)								X						
Oxamyl (Vydate)								X						
PAHs (Di<ethylhexyl>phthalate								X						
Pichloram								X						
Simazine								X					X	
1,2,4-Trichlorobenzene								X					X	
1,1,2-Trichloroethane								X						
2,3,7,8-TCDD (Dioxin)														

KEY TO SYMBOLS

AAA	Acitvated Alumina Adsorption
CLO	Chlorine Oxidation
CON	Convention Treatment Including Coagulation and Filteration
CC	Corrosion Control
DF	Direct Filteration
DIF	Diatomite Filteration
ED	Electrodialysis
GAC	Granular Activated Carbon
IE	Ion Exchange
LS	Lime Softening
PAP	Polymer Addition Practices
PTA	Packed Tower Aeration
RO	Reverse Osmosis
UV	Ultraviolet

3 SUMMARY OF THE NEW REGULATIONS

The USEPA may set one of four types of standards for a contaminant in drinking water. These standards are: the Maximum Contaminant Level Goal (MCLG), the Maximum Contaminant Level (MCL), the Secondary Maximum Contaminant Level (SMCL), and treatment technique requirements. Treatment technique requirements and MCLs are enforceable standards. MCLGs and SMCLs are nonenforceable. MCLs and treatment technique requirements are the primary methods by which the USEPA controls the quality of drinking water.

Maximum Contaminant Level Goal

The definition of an MCLG is "a concentration level of a contaminant at which no known or anticipated adverse effect on the health of persons would occur and allows for an adequate margin of safety."[2] Prior to the 1986 amendments, the MCLG was called the Recommended Maximum Contaminant Level (RMCL). Every contaminant the USEPA regulates in drinking water will have an MCLG associated with it. MCLGs are nonenforceable goals that represent the ideal maximum level of a contaminant. They are used as a reference in setting the enforceable standards. All contaminants that are known human or animal carcinogens will be assigned an MCLG of zero.

Maximum Contaminant Level

An MCL is an enforceable standard defined as "the maximum permissible level of a contaminant in water delivered to the free-flowing outlet of the ultimate user of a public water system, except in the case of turbidity (cloudiness) where the maximum permissible level is measured at the point of entry into the distribution system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition."[3] MCLs are set as close to the MCLGs as feasible with the use of best available technology, treatment techniques, and other means, taking cost into consideration. The MCL is a numerical limit on the amount of a particular contaminant allowed in treated water. The MCL for turbidity is measured at the point of entry into the distribution system. For most other contaminants the MCL controls the water quality in the distribution system.

Treatment Technique Requirements

If it is not technologically or economically feasible to determine a numerical level of a contaminant, in order to comply with an MCL, the USEPA may require the use of a treatment technique instead. A treatment technique takes the place of an MCL for contaminants that are difficult or expensive to monitor, (e.g., *Giardia Lamblia).*

A treatment technique requirement compels a water system to use an already proven technology to attain a required level of removal. For example, for *Giardia Lamblia*, the level of removal must be 99.9 percent, or "3 log." USEPA reviews research on different treatment methods and determines which methods can attain the required level of removal. For Giardian Lamblia USEPA determined that the use

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[2] 40 Code of Federal Regulations (CFR) 141.2, *Protection of the Environment, National Priority Drinking Water Regulations—Definitions* (1 July 1990).

[3] 40 CFR 141.2.

of filtration techniques, controlled by operating requirements, can meet the 3 log removal requirement. By defining treatment technique requirements, USEPA required plants to use specified treatment methods but does not require them to measure the level of contaminant in the treated water.

As an example, USEPA is required by Congress to promulgate regulations specifying criteria under which filtration is required as a treatment technique for public water systems using surface water sources. This is partially due to the potential presence of *Giardia* cysts.

Every contaminant regulated by the USEPA will have associated with it either an MCL or a treatment technique. All contaminants will have MCLGs associated with them.

Secondary Maximum Contaminant Level

An SMCL decribes a limit above which contaminant levels may affect the aesthetic qualities and public acceptance of the drinking water. The SMCL is not associated with health effects and is not Federally enforceable. The SMCL is usually associated with prevention of taste and odor problems, and, in the case of the SMCL for fluoride, prevention of dental fluorosis. Table 4 lists the current SMCLs.

Standardized Monitoring Framework for Organic Chemicals

When USEPA finalized SOCs and IOCs (II) on 30 January 1991, the rule included a standardized monitoring framework. This framework is intended to lend consistency to the monitoring requirements for all regulated organic chemicals. Also on 30 January 1991, USEPA proposed changes to the previously finalized VOCs Rule to make its monitoring requirements consistent with the new framework.

The new framework is based on 9 year *compliance cycles* divided into 3 year *compliance periods*. The first compliance cycle begins on 1 January 1993 and continues until 31 December 2001. The second cycle will begin on 1 January 2002, and so on.

The new regulations involving synthetic organic and inorganic chemicals would require an initial monitoring period. This initial monitoring would take place in the first full compliance period after the effective date of the regulation.

For all VOCs, the inital monitoring would consist of one year of quarterly samples, regardless of system size or source water type. All systems that did not detect VOCs in the initial monitoring would be required to repeat monitoring annually beginning in the calendar year after the initial monitoring. Systems in which VOCs were detected would be required repeat monitoring quarterly. As of this writing, the proposed changes to the VOCs Rule and the standardized monitoring framework had not been finalized, so the original VOCs Rule requirements were still in effect.

New Regulations

As discussed earlier, the new regulations are being promulgated in the form of 11 new rules, which fall into the general categories of final rules, Proposed Rules, and Upcoming Rules. This report is predominantly concerned with the rules finalized and published as of June 1991: the Fluoride Rule, the Total Coliform Rule, the Surface Water Treatment Rule, the Volatile Organic Chemicals Rule, and the Synthetic Organic Chemicals and Inorganic Chemicals Rule (Phase II), and the Lead and Copper Rule. As of this writing, the radionuclides rule had recently been finalized, but not in time for inclusion in this

Table 4

Secondary Maximum Contaminant Levels in Drinking Water

Contaminant	Level
Current SMCLs	
Chloride	250 mg/l
Color	15 color units
Copper	1 mg/l
Corrosivity	Noncorrosive
Fluoride	2.0 mg/l
Foaming Agents	0.5 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	3 threshold odor number
pH	6.5 - 8.5
Sulfate	250 mg/l
Total Dissolved Solids	500 mg/l
Zinc	5 mg/l
Proposed SMCLs	
Aluminum	0.05 mg/l
o-Dichlorobenzene	0.01 mg/l
p-Dichlorobenzene	0.005 mg/l
Ethylbenzene	0.03 mg/l
Hexachlorocyclopentadiene	0.008 mg/l
Pentachlorophenol	0.03 mg/l
Silver	0.09 mg/l
Toluene	0.04 mg/l
Xylenes (total)	0.02 mg/l

report. Upcoming rules are still in their preliminary phases and have not yet even been proposed. The timetable in Figure 1 shows the time relationships among the various rules.

A brief discussion of each final rule follows. Full explanations of each final rule published as of June 1991 may be found in Appendixes A through F.

The Volatile Organic Chemicals Rule

VOCs are chemicals often used as solvents, and they may also be the breakdown products of solvents. They get into drinking water through improper disposal or, in the case of benzene, through contamination of water by gasoline spilled or leaking from a tank. Table 5 lists the chemicals regulated under the VOCs Rule, and the sources of these chemicals.

The most significant parts of this rule are the monitoring requirements. Monitoring requirements for both regulated compounds and unregulated compounds make up the bulk of this rule. From the monitoring of unregulated contaminants USEPA expects to collect data on the occurrence of these contaminants in drinking water. These data will be used to establish the drinking water priority list.

Table 5

Compounds Included in the VOCs Rule

Chemical	Source/Use
Benzene	Gasoline additive, metal degreaser, and solvent
Carbon Tetrachloride *para*-Dichlorobenzene	Dry cleaning fluid component of deodorizers, mothballs, and pesticides
1,2-Dichloroethane 1,1-Dichloroethylene	Cleaning fluid Breakdown product of solvents used as metal degreasers and cleaners
1,1,1-Trichloroethane Trichloroethylene (TCE)	Metal degreaser and cleaner Metal cleaning and dry cleaning
Vinyl Chloride	Breakdown product of solvents used as metal degreasers and cleaners

MCLs have been established for eight VOCs. A table of values is found in Appendix A for the VOCs Rule. Several of the VOCs are known carcinogens and, consequently, have MCLGs of zero. Regulations on other VOCs included in SOCs and IOCs (II) and the proposed SOCs and IOCs (V) Rule.

The rule requires an initial monitoring to be completed by all systems. The details of how this monitoring is to be completed are included in Appendix A. When USEPA finalized SOCs and IOCs (II), they again proposed the repeat monitoring requirements for the VOCs Rule so the requirements would be consistent for all VOCs.

The BAT for volatile organic chemicals is packed-tower stripping or granular activated carbon adsorption. For vinyl chloride, packed-tower stripping is the only BAT.

The Fluoride Rule

Fluoride is considered a desirable addition to many water treatment systems because of its effects in reducing dental caries, but, at high levels, it can be damaging to health. The Fluoride Rule limits the amount of fluoride that can be present both naturally and artificially.

The Fluoride Rule was finalized in April 1986. At this time, the rule is under review and the revised form is expected in 1991. There has been substantial debate on the validity of the health effects data originally collected. New health effects data were collected by the USEPA to facilitate the rule-review process. This review also fulfills the requirement that all drinking water regulations be reviewed once every 3 years.

There are three separate standards associated with fluoride. The MCL is 4.0 mg/l to protect against skeletal fluorosis, the MCLG is also 4.0 mg/l, and the SMCL is 2.0 mg/l to protect against dental fluorosis. The USEPA has decided that dental fluorosis is not a serious health effect and has considered only skeletal fluorosis in setting the fluoride standard. However, the Fluoride Rule has a special requirement for annual public notification if the SMCL is violated. This is to inform people that their teeth may be affected by the level of fluoride in the water.

Appendix B contains a more complete description of the Fluoride Rule.

The Surface Water Treatment Rule

The SWTR regulates filtration, disinfection, turbidity, *Giardia Lamblia*, viruses, *Legionella*, and heterotrophic bacteria for public water systems with surface water sources and groundwater sources under the influence of surface water. This rule is complex in how it interfaces with other rules.

The principal components of the SWTR include: filtration requirements, criteria to avoid filtration, disinfection requirements, disinfection criteria (operating requirements), and turbidity standards.

The most important categories of microorganisms found in drinking water are shown in Table 6. The regulations themselves focus on *Giardia, Legionella*, viruses, and heterotrophic plate count (HPC) bacteria. The removal of turbidity is also considered important because suspended particles can hinder the disinfection process. Recent evidence of disease outbreaks associated with a bacterial cyst, *Cryptosporidium*, has increased interest in this particular microorganism, but it is not yet part of the regulations. *Cryptosporidium* now appears on the 1991 version of the drinking water priority list.

The purpose of filtration is to remove particulate matter. Of the microorganisms listed above, *Giardia* is most effectively removed through filtration. Since USEPA believes that filtration in conjunction with coagulation and disinfection is the most effective method for removal of pathogenic organisms, the SWTR requires filtration of all surface water sources and groundwater sources under the influence of surface water. It is possible to avoid this requirement by meeting a complicated set of criteria. These criteria are described in detail in Appendix C.

Disinfection is the other major requirement of the SWTR. The treatment technique requires achievement of a minimum level of microorganism removal, specifically for *Giardia* and viruses. Commonly, levels of removal are referred to as "removal credits." Removal credits are accumulated through both filtration and disinfection practices. The overall treatment of drinking water must achieve a removal efficiency of 99.9 percent for *Giardia* and 99.99 percent (4 log) for viruses. This is also referred to as 3- and 4-log removal, or 3 and 4 credits respectively. Filtration counts for some removal credits as shown in Table 7. If a system has one of these types of filtration, it is allowed to count the filtration towards the total necessary log removal.

The level of disinfection is calculated by a "CT value." The C value is the residual disinfectant concentration. T is the disinfectant contact time. Explanations of how C and T are calculated are included in Appendix C. Each CT value is associated with a certain number of disinfection credits. Within this rule USEPA has specified levels of disinfection, each associated with a CT value for each type of disinfectant. To determine a system's requirements under SWTR, items to consider include the treatment practices that are in place and whether the practices can attain the required total log removal levels.

The Total Coliform Rule

The coliform group includes both microorganism species found in the human intestines and species that grow solely in the soil. Coliforms are of interest in drinking water mostly because they serve as an indicator for fecal contamination and, therefore, enteropathogenic microorganisms. Coliform presence in water may or may not indicate fecal contamination, but their absence is assumed to mean that the water has not been contaminated. They are a reasonably good indicator group, but because they are not a perfect indicator group for all contaminants, SWTR requires additional treatment for certain contaminants, such as *Giardia* and viruses.

Table 6

Biological Contaminants in Drinking Water

Viruses
- Hepatitis A
- Norwalk-type
- Rotaviruses
- Adenoviruses, enteroviruses, and reoviruses

Protozoans
- *Giardia Lamblia*
- *Entamoeba histolytica*
- *Cryptosporidum*
- *Naegleria fowleri*

Bacteria
- *Salmonella*
- *Shigella*
- *Yersinia enterocolitica*
- *Campylobacter jejuni*
- *Legionella*
- Enteropathogenic *E. coli*
- *Vibrio chlolerae*
- Mycobacteria
- Opportunistic Bacteria (HPC)
  - *Pseudomonas*
  - *Aeromonas hydrophilia*
  - *Edwardsiella tarda*
  - *Citrobacter*
  - *Klebsiella*
  - *Enterobacter*
  - *Serratia*
  - *Proteus*
  - *Providencia*
  - *Acinetobacter*

Some coliform species can cause disease and, therefore, are of concern from a health standpoint. Several of the coliform group are considered "opportunistic pathogens." These are organisms that do not usually cause disease in healthy adults, but can cause disease in newborns, elderly people, and people whose immune system is weak due to another illness. One common example is *Klebsiella pneumoniae*.

Another important issue associated with coliforms is the problem of regrowth in drinking water distribution systems. *Klebsiella pneumoniae* is one coliform species that is most successful at colonizing in distribution systems. Once a coliform species has colonized, the mass of cells is subject to occasional "sloughing off," or release of cells in the distribution system. These cells then show up at the tap. Because of this sloughing off characteristic, regrowth of coliforms in the distribution system is a problem. Regrown coliforms can show up in distribution system sampling when no fecal contamination has taken place. When this happens, the coliform is no longer acting as an indicator. Total coliform positive samples can trigger a "boil water" notice by the system administrator. Regrowth is a problem that needs to be addressed in many distribution systems.

The Total Coliform Rule uses the coliform group as an indicator of microbial quality of drinking water. The rule is designed on the premise that absence of coliform indicates an absence of fecal contamination, and presence of coliform indicates the possibility of contamination by entero-pathogenic

Table 7

Recommended Minimum Level of Disinfection and Assumed Log Removals By Filtration Method

Treatment	Assumed Log Removal	Recommended Minimum Level of Disinfection	Total Log* Removal
Giardia			
Conventional	2.5	0.5	3.0
Direct Filtration	2.0	1.0	3.0
Slow sand filtration	2.0	1.0	3.0
Diatomaceous earth filtration	2.0	1.0	3.0
Viruses			
Conventional	2.0	2.0	4.0
Direct Filtration	1.0	3.0	4.0
Slow sand filtration	2.0	1.0	4.0
Diatomaceous earth filtration	1.0	2.0	4.0

*See page 24 for definition of log removal.

organisms. Therefore, the new coliform regulations are based on a presence-absence concept of coliform measurements rather than on the previous density-based measurements.

The primary requirements of the Total Coliform Rule are monitoring requirements in the distribution system. The MCL is defined as follows:

- For a system that collects at least 40 samples per month, if no more than 5.0 percent of the samples collected are total-coliform positive, the system is in compliance with the MCL for total coliforms.
- For a system that collects fewer than 40 samples per month, if no more than one sample collected during a month is total-coliform positive, the system is in compliance with the MCL for total coliform.[4]

Table 8 summarizes the monitoring requirements. The Total Coliform Rule describes in detail how and when samples must be taken, when they should be repeated, and how they should be analyzed. The monitoring requirements for the Total Coliform Rule are described in detail in Appendix D.

The Synthetic Organic Chemicals and Inorganic Chemicals (Phase II) Rule

This rule is directed primarily at chemicals found in the environment due to human activity, also described as source-related contamination. Exposure to many of these chemicals is a direct result of their use in manufacturing and agriculture. Synthetic organic chemicals include both volatile and nonvolatile

[4] 40 CFR 141.63.

Table 8

Total Coliform Rule Monitoring Requirements

Number of Samples Collected per Month	< 40	≥ 40
Allowable Total Coliform Positive Samples	1	5% of samples

contaminants such as pesticides, solvents, and chemical byproducts of industry. Inorganic chemicals are often found naturally in water, but their concentrations in the environment can be increased due to human activity. Table 9 shows the chemicals currently regulated by SOCs and IOCs (II). Additionally, the rule includes provisions for monitoring chemicals not currently regulated (see Table 10).

As required, USEPA has determined the BAT to meet the new MCLs for organics. BATs to remove the inorganic chemicals vary widely, depending on the contaminant. More conventional technologies included are lime softening and coagulation/filtration. Less common alternatives include reverse osmosis and activated alumina. Granular activated carbon is BAT for all synthetic organic chemicals, and packed-tower aeration is BAT for many.

For acrylamide and epichlorohydrin, treatment techniques will define compliance. Both of these chemicals are impurities found in water-treatment chemicals such as coagulant aids.

Within this rule, USEPA has introduced a standard monitoring framework to address the issue of complexity, coordination of monitoring requirements among various regulations, and synchronization of monitoring schedules. USEPA intends to apply this framework to all future regulations of similar contaminants. The repeat monitoring requirements of the VOCs Rule were reproposed so they would be consistent with the standard framework.

USEPA has established 9 year compliance cycles. Each 9 year cycle consists of three 3 year compliance periods. The first 9 year cycle begins 1 January 1993, and ends 31 December 2001. This timetable establishes consistency with the dates of monitoring requirements for VOCs and SOCs. contaminants.

The monitoring requirements generally follow a three-tier approach that was introduced in 1983. Tier I contaminants occur frequently and States are required to adopt USEPA's minimum requirements for monitoring. Tier II contaminants occur less frequently and depend on regional conditions. For these contaminants, States are allowed some flexibility in establishing monitoring criteria. Tier III contaminants are not regulated by USEPA, but States may be given health advisories pertaining to the health effects of these contaminants. Within the SOCs and IOCs (II) Rule, nitrate is the only contaminant that falls into Tier I. All of the remaining contaminants are considered Tier II, which allows some flexibility for the States.

As indicated previously, the SOCs and IOCs (II) Rule includes requirements to monitor unregulated contaminants. The USEPA has proposed giving the States the responsibility of performing a vulnerability assessment for each of the contaminants on List 1 (Table 10). This would determine which systems are required to monitor for these contaminants. The State may require the monitoring of List 2 contaminants at its discretion. Appendix E includes a detailed discussion of SOCs and IOCs (II).

Table 9

Compounds Included in the SOCs and IOCs (II) Rule

Chemical	Source or Use
Inorganic Chemicals	
Asbestos	Corrosion of Asbestos-Cement Pipe, Geological
Barium	Geological trace element
Cadmium	
Synthetic Organic Chemicals	
Acrtlamide	Flocculant, soil conditioning agent, ore processing
Alachlor	Herbicide
Aldicarb	Nematocide, Insecticide
Aldicarb Sulfoxide	Pesticide
Aldicarb Sulfone	Pesticide
Atrazine	Herbicide, plant growth regulator, weed control
Carbofuran	Pesticide (corn rootworm and rice water weevil)
Chlordane	Insecticide - legal only for termites
Dibromochloropropane	Pesticide, Nematocide, Fumigant
ortho-Dichlorobenzene	Solvent, Fumigant, Insecticide
cis-Dichloroethylene	Solvent
trans-Dichloroethylene	Solvent
1,2-Dichloropropane	Lead scavenger, solvent, metal degreaser, soil fumigant
2,4-D	Selective weed killer and defoliant, fruit drop control
Epichlorohydrin	Water treatment, raw material for epoxy and phenozy resins
Ethylbenzene	Solvent, intermediate in production of styrene
Ethylene Dibromide	Scavenger for lead in gasoline, Grain Fumigant, Solvent, Fumigant
Heptachlor	Insecticide, Use restricted to termites
Heptachlor Epoxide	Degradation product of Heptachlor, Insecticide
Lindane	Pesticide
Methoxychlor	Insecticide (mosquito larvae and houseflies)
Monochlorobenzene	Solvent, Pesticide
PCBs	Transformers, Capacitors
Pentachlorophenol	Fungicide, Bactericide, Algicide, Herbicide, Wood Preservative - Nonwood uses banned in 1987

Table 9 (Cont'd)

Chemical	Source or Use
Styrene	Manufacture of polystyrene and other resins, coatings etc.
Tetrachloroethylene	Dry-cleaning solvent, vapor-degreasing solvent, mfg. of fluorocarbons
Toluene	Aviation gasoline, high octane blending stock, solvent, thinner, etc.
Toxaphene	Insecticide
2,4,5-TP (Silvex)	Herbicide and plant growth regulator
Xylenes (ortho, meta, para)	Aviation gasoline, Solvent

Lead and Copper Rule

The Lead and Copper Rule (Appendix F) is primarily intended to control corrosion byproducts. This rule (1) requires a treatment technique requirement to optimize corrosion control, and (2) sets action levels for lead and copper. Another regulation of interest in controlling lead is the Lead Contamination and Control Act of 1988, which amended the Safe Drinking Water Act. "*Opflow*, published by the American Water Works Association, gives a good summary of the Lead and Copper Rule in four installments from Vol 17, No. 8 to Vol 17, No. 11 (August 1991 to November 1991)."

Lead gets into water primarily through leaching from pipes, joints, coolers, and other lead-based water transfer or storage equipment, usually after it has left the water treatment plant. Copper gets into drinking water through similar pathways. The methods of controlling the amount of lead and copper include both reducing the amount of lead and copper used in construction of water systems and reducing the tendency of water to corrode the systems that do have lead or copper in them. Lead can be found in source water, but source water is not the primary pathway for lead exposure.

The negative health effects of lead have been well researched, especially in children. The health effects of copper are not as well documented. Copper is essential as a nutrient in low doses, and is toxic at high doses. Lead has been shown to be carcinogenic in some cases, so USEPA has finalized an MCLG of zero for lead. Copper is classified as a Group D carcinogen, which means that not enough information is available to determine carcinogenic potential. The MCLG for copper is 1.3 mg/l. Much of the attention to this rule has been focused on the lead standard because of that metal's greater apparent health risks.

The first steps toward controlling lead in distribution systems were taken by Congress in the SDWA Amendments of 1986. First, lead-based solder or flux, and lead pipes were banned from use in water systems after 19 June 1986. Second, lead was placed on the list of contaminants that the USEPA is required to regulate. Through the Lead and Copper Rule, the USEPA is setting MCLs and treatment technique requirements to control these corrosion byproducts.

The Lead Contamination and Control Act of 1988 added responsibilities to USEPA's list for the control of lead.[5] The first responsibility on this list was to prepare a list of lead-containing water coolers.

[5] *Proposed List of Non-Lead Free Coolers*, 54 FR 14320, 10 April 1989.

Table 10

Unregulated Contaminants To Be Monitored Under the SOCs and IOCs (II) Rule

List 1	*List 2*	
Aldrin	Ametryn	Napripamide
Antimony	Aspon	Norflurazon
Beryllium	Atraton	Pebulate
Butachlor	Azinphos methyl	Phorate
Carbaryl	Bolstar	Phosmet
Cyanide	Bromacil	Prometon
Dalapon	Butylate	Prometryn
2,4-DB	Carboxin	Pronamide
Dicamba	Chlorpropham	Propazine
Dieldrin	Coumophos	Simetryn
Dinoseb	Cycloate	Stirofos
Hexachlorobenzene	Demeton-O	Tebuthiuron
Hexachlorocyclopentadiene	Demeton-S	Terbacil
3-Hydroxycarbofuran	Diazinon	Terbufos
Glyophosphate	Dichlofenthion	Terbutryn
Methomyl	Dichlorvos	Triademefon
Metolachlor	Diphenamid	Tricyclazole
Metribuzin	Disulfoton	Vemolate
Nickel	Disulfoton sulfone	Chlorneb
Oxamyl (vydate)	Disfulfoton sulfoxide	Chloropropylate
PAHs	EPN	Chlorobenzilate
Pthalates	EPTC	Chlorpyrifos
Pichloram	Ethion	DCPA
Propachlor	Ethoprop	4,4'-DDD
Simazine	Ethyl parathion	4,4'-DDE
Sulfate	Famphur	4,4'-DDT
2,3,7,8-TCDD	Fenamiphos	Dichloran
2,4,5-T	Fenarimol	Endosulfan I
Thallium	Fenitrothion	Endosulfan II
	Fensulfothion	Endosulfan sulfate
	Fenthion	Endrin Aldehyde
	Fluoridone	Etridiazole
	Fonofos	HCH-alpha
	Hexazinone	HCH-beta
	Malathion	HCH-delta
	Merphos	HCH-gamma
	Methyl Paraoxon	cis-Permethrin
	Methyl Parathion	trans-Permethrin
	Mevinphos	Trifluralin
	MGK 264	Diquat
	MGK 326	Endothall
	Molinate	

After this list was prepared, the Consumer Product Safety Commission was to issue an order requiring manufacturers to repair, replace, or recall (and issue refunds for) all water coolers of the types on the list. Congress also prohibited interstate commerce in lead-containing water coolers. USEPA's second responsibility is to publish a guidance document and a testing protocol to help school officials determine the source and degree of lead contamination in school drinking water supplies and remedy such

contamination.[6] These requirements supplement the responsibilities given the USEPA through the original Safe Drinking Water Act.

The Lead and Copper Rule establishes MCLGs, action levels, and treatment techniques for both lead and copper. The action levels are levels at which a system would be required to start a corrosion control program. For lead the action level is 0.015 mg/l, and for copper the action level is 1.3 mg/l. These action levels are not the same thing as an at-the-tap MCL: they are measurements of the levels present in 90th percentile of samples taken from consumers' taps. Exceedance of the action levels triggers a requirement for corrosion control, but not the kind of penalties assessed for violating an MCL.

The treatment technique requirement for lead includes four components: optimal corrosion control treatment, source water treatment, public education, and lead service line replacement. The treatment technique for copper includes two components: optimal corrosion control treatment and source water treatment. The treatment technique requirements are triggered by the exceedance of the action levels.

In the proposed Lead and Copper Rule, an action level was proposed for acidity and alkalinity, but it is not in the final rule. The only action levels in the final rule are for lead and copper levels at the consumer's tap.

Proposed Rules

Synthetic Organic Chemicals and Inorganic Chemicals Rule (Phase V)

In addition to the finalized rules discussed so far, one rule has been proposed but not finalized: SOCs and IOCs (V). This rule is expected to be finalized in 1992.

This second SOCs and IOCs rule is an extension of the first. It was proposed 25 July 1990. Many of the requirements are the same as in the SOCs and IOCs (II) Rule, to provide continuity to the regulations. Monitoring for any VOCs covered under this rule will follow the standardized monitoring framework for SOCs and IOCs (II).

The contaminants covered by the SOCs and IOCs (V) Rule are listed in Table 11. Unlike the SOCs and IOCs (II) Rule, there are no unregulated contaminant monitoring requirements.

BAT designated for all of these contaminants (except for methylene chloride) is GAC. Packed-tower aeration is also designated BAT for adipates, methylene chloride, hexachlorocyclopentadiene (HEX), 1,1,2-trichloroethane, and 1,2,4-trichlorobenzene.

Upcoming Rules

As previously indicated, four rules are still in development. These are the Disinfection/Disinfection Byproducts Rule (D/DPB), the Groundwater Disinfection Rule, the Radionuclides Rule, and the Revised Arsenic Rule. Since these rules are not yet officially proposed, their ultimate contents are unknown. However, there have been some preliminary indications of what the rules will include.

The Surface Water Treatment Rule regulates minimum disinfection requirements by defining the minimum levels of disinfection. The D/DBP Rule will regulate the maximum allowable amount of disinfectant. A concern with this upcoming rule is how it will interface with the current Surface Water Treatment Rule. The concern with disinfection byproducts is centered around a group of compounds

[6] *Lead in School Drinking Water*, EPA 570/9-89-001 (USEPA, January 1989).

Table 11

Compounds Included in the SOCs and IOCs (V) Rule

Chemical	Source or Use
Inorganic Chemicals	
Antimony	Geological, flame retardant,
Beryllium	Geological, electrical equip.
Cyanide	Electroplating, steel processing, plastics, fertilizer
Nickel	Geological, electroplating, stainless steel
Sulfate	Geological, wide range use in chemical industry
Thallium	Geological, Electronics, pharmaceuticals
Synthetic Organic Chemicals	
Adipates	Plasticizer
Dalapon	Herbicide
Dichloromethane (Methylene Chloride)	Solvent, Degreaser
Dinoseb	Pesticide
Diquat	Herbicide
Endothall	Herbicide
Endrin	Pesticide (banned in U.S.)
Glyphosate	Herbicide
Hexachlorobenzene	Impurity in solvents
Hexachloro-cyclopentadiene	Intermediate in manufacture of pesticides and flame retardants.
Oxamyl (Vydate)	Pesticide
PAHs	
Phthalates	
Picloram	Broadleaf weedkiller
Simazine	Herbicide
1,2,4-Trichlorobenzene	Dye carrier, precursor to pesticides
1,1,2-Trichloroethane	Intermediate in production of 1,1-dichloroethylene
2,3,7,8-TCDD (Dioxin)	Impurity in pesticide production

called trihalomethanes (THMs). These compounds appear in drinking water after water with naturally occurring organic matter has been disinfected with chlorine. THMs have been shown to be potentially harmful to health. To control the amount of THMs in drinking water, it is necessary to control the amount of chlorine in that water. It is possible that some systems will not be able to comply with both the Surface Water Treatment Rule and the D/DBP Rule while using chlorine as a disinfectant.

A draft of the D/DBP Rule has been released in the form of a "strawman" rule. This draft gives an indication of what USEPA is considering.

The Groundwater Disinfection Rule will regulate groundwater similarly to how the Surface Water Treatment Rule regulates surface water. It will focus on requirements for treatment of microbial contaminants.

The Radionuclides Rule will consist of a revision of the current standards, but may be more stringent.

The standard for arsenic is currently under review. USEPA must assess the sufficiency of data for proposing a regulation by 1 June 1991. If there are sufficient data, USEPA will propose a standard within 18 months. If there are not enough data, USEPA has 7 years to collect more data and propose a standard.

It must be kept in mind that these rules are still being developed and are subject to change.

The D/DBP Strawman Rule

Regulations. The D/DBP Strawman Rule (Appendix G) is a preliminary description of some of the regulations that may comprise the final D/DBP Rule. The proposed rule is not expected until June 1993, and the final rule 18 months after that.

MCLs and MCLGs will be established for selected contaminants associated with disinfection and disinfection byproducts. These regulations will cover previously unregulated byproducts such as the haloacetic acids, haloacetonitriles, and haloketones. Table 12 shows the potentially regulated contaminants. The standard for the well known THM byproducts of the free chlorine reaction with organic compounds will probably be reduced from its current value of 100µg/L. USEPA is considering values for the THM standard of 25µg/L or 50µg/L.

Other byproducts being considered for regulation are chloropicrin, cyanogen chloride, and formaldehyde. Formaldehyde is a member of the THM group but may be regulated independently as well.

The D/DBP Rule will also establish limits on the amount of disinfectant that can be present in water. The most likely compounds to be regulated are chlorine, chloramine, and chlorine dioxide. One way of regulating these may be through a total oxidizing substances MCL.

Treatment techniques may be required for selected surrogate parameters* such as MX,** total oxidizing substances, and assimilable organic carbon (AOC). Under this rule, MX would be a surrogate for mutagenicity, total oxidizing substances a surrogate for organic peroxides and epoxides, and AOC as a surrogate for microbiological quality of oxidized waters.

Monitoring. Monitoring requirements will be based on the disinfection treatment applied. Table 13 shows the parameters under consideration for each of the disinfection techniques.

Best Available Technology. Three types of BAT are being considered for this category of contaminant: precursor removal techniques, alternative oxidants, and byproduct removal. Potential precursor removal techniques include conventional treatment modifications, GAC adsorption, and membrane processes. Alternative oxidants may include chlorine dioxide or ozone, each used with chloramines, to provide a residual disinfectant in the distribution system. Removal of byproducts might be achieved by such methods such as stripping, GAC adsorption, or reducing agents.

Interaction With Other Rules. One important aspect of a D/DBP Rule is its interaction with other rules. The three rules with which it is most likely to interact are the Surface Water Treatment Rule, the Lead and Copper Rule, and SOCs/IOCs (II).

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* A surrogate parameter is an easily measured representative of a more complex water quality characteristic.

** MX = 3 chloro 4-(dichloro methyl-5-hydrox-2(5H) furanone.

Table 12

Candidates for Regulation Under the D/DBP Rule

Candidate Disinfectants	Candidate Chlorination Byproducts
Chlorine	Trihalomethanes
Hypochlorite Ion	Chloroform
Hypochlorous Acid	Bromodichloromethane
	Dibromochloromethane
	Bromoform
Chloramine	Haloacetic Acids
Ammonia	Monochloroacetic Acid
	Dichloroacetic Acid
Chlorine Dioxide	Bromochloroacetonitrile
Chlorite	Dibromoacetonitrile
Chlorate	
Candidate Ozonation byproducts	
Organics	Haloketones
Aldehydes (formaldehyde, acetaldehyde, hexananl, and heptanal)	1,1-Dichloropropane
Organic Acids	1,1,1-Trichloropropane
Ketones	Other
Epoxides	Chloropicrin
Peroxides	Chloral Hydrate
Nitrosamines	
N-Oxy Compounds	
Quinoones (polyhydroxphenols)	
Bromine Substituted Compounds	
Inorganics	Chlorophenols
Hydrogen Peroxide	2-Chlorophenol
Bromate	2,4-Dichlorophenol
Iodate	2,4,6-Trichlorophenol
Chlorate	Cyanogen Chloride
	MX [3-chlor-4-(dichloromethyl)-5-hydroxy-2(5H)furanone]
	N-Organochloramines

Four potential interactions with the SWTR are described in the Strawman Rule:

1. CT values used to calculate compliance might be used to predict byproduct levels

2. Turbidity removal requirements for the SWTR could have a positive impact on precursor removal

3. A disinfectant residual of 0.2 mg/l is required in the distribution system; if this residual is free chlorine, then it is important in determining DBP levels

4. Chloramine may not be universally applicable, so the elimination of chlorine may not be feasible.

There are also possible interactions with the Lead and Copper Rule, which establishes no-action levels where a system is not required to initiate corrosion control. One of these no-action levels is a pH of 8: a pH greater than 8 favors THM formation and suppresses formation of acids and other byproducts. Another possible interaction is that at higher pH, higher CT values are required. Removing organic chemicals to comply with THM regulation may improve corrosion control.

Table 13

Potential Monitoring Parameters Based on Treatment Process

Treatment Process	Monitoring Parameters Under Consideration
Chlorination	TTHMs Haloacetic Acids Total Organic Halides Total Oxidizing Substances Chloropicrin Cyanogen Chloride Total Chlorine Residual
Chloramination	TTHMs Chloropicrin Cyanogen Chloride Total Chloramine Residual
Chlorine Dioxide	Total Oxidizing Substances Chlorine Dioxide Chlorite Chlorate
Ozonation	Formaldehyde Total Oxidizing Substances Bromate Iodate Hydrogen Peroxide

The Groundwater Disinfection Strawman Rule

The GWDR Strawman Rule requires disinfection of groundwater sources similar to the way the Surface Water Treatment Rule required disinfection of surface water sources. The SDWA Amendments required USEPA to promulgate disinfection requirements for all public water systems. The GWDR will complete that requirement. This rule will focus on removal of viruses, *Legionella*, and HPC bacteria. Since turbidity and *Giardia* are not generally a concern in groundwaters, these items do not need to be regulated.

Disinfection Requirements. The anticipated general requirements will include treatment technique requirements in lieu of MCLs for viruses, HPC bacteria, and *Legionella*. All public water systems will be required to disinfect. Several options are being considered for the specific disinfection requirements.

The requirements for the level of inactivation could take one of four forms:

1. Disinfection is required, but the level would be up to the State, and the State would specify design and operating conditions

2. USEPA would specify a minimum level of inactivation, and the State would specify the design and operating conditions

3. A combination of options 1 and 2 above

4. USEPA would specify CT values (as it does for the SWTR) and the water system administrators must demonstrate compliance.

For continuity of disinfection requirements, there are basically two options:

1. The State would be responsible for specifying enforceable criteria

2. USEPA would adopt enforceable criteria similar to those for the SWTR.

Distribution system requirements have similar options:

1. Allow State discretion

2. USEPA would specify residual requirements (similar to the SWTR)

3. A combination of options 1 and 2.

The GWDR will possibly be set up the same way the SWTR is set up: compliance will be based on meeting a particular CT value, which reflects a specified removal level.

4 IMPORTANT SDWA ISSUES FOR WATER SYSTEM MANAGERS

Wellhead Protection Program

The SDWA Amendments established the State Wellhead Protection Program (WHPP) to protect from contamination groundwater resources used as drinking water. Each State is required to adopt and submit to the USEPA a program that meets USEPA requirements. A few of USEPA's requirements are listed below:

- Specify duties of government entities
- Define a wellhead protection area (WHPA) for each well
- Identify within each WHPA all possible anthropogenic sources of contamination
- Describe a program to protect that water supply
- Include contingency plans for alternative sources of drinking water.

USEPA will approve or disapprove of each WHPP. The deadline for submission was 19 June 1989. As of February 1991, many States had not submitted a WHPP and several States do not intend to submit a plan. Although each State is required to submit a plan, USEPA has little enforcement capability on this issue.

Groundwater systems in States that develop a USEPA-approved WHPP may be subject to new regulations designed to protect groundwater sources. The best source of information on this subject is the State regulatory agency.

State Primary Enforcement Responsibility Requirements

SDWA establishes requirements for a State to obtain primary enforcement responsibility (primacy) for the Public Water System Supervision Program (PWSS). A State that has primacy has the direct responsibility for administration and enforcement of both Federal and State drinking water regulations.

A State must meet five basic requirements to obtain primacy:

1. Adopt drinking water regulations no less stringent than the National Primary Drinking Water Regulations

2. Adopt and implement procedures to enforce drinking water regulations (although an Indian Tribe will not be required to exercise criminal enforcement)

3. Adopt and maintain recordkeeping procedures

4. Adopt requirements to obtain variances or exemptions no less stringent than those conditions specified in the SDWA

5. Adopt and be able to implement a plan to provide water in emergency situations.

In order to adequately enforce drinking water regulations, according to the USEPA, a State must also meet several other requirements as follows:

1. Maintain an inventory of PWSs

2. Adopt a systematic procedure for conducting sanitary surveys

3. Establish and maintain a State program for the certification of laboratories

4. Assure compliance with State regulations by new or substantially modified PWSs, and

5. Obtain authority to compel compliance with State drinking water regulations.

Operator Certification Requirement

The SWTR requires that every PWS using surface water or groundwater under the influence of surface water must be operated by qualified personnel who meet the requirements specified by the State. The State is responsible for qualifying operators as part of the primacy requirements. In States that do not have primacy, qualifying would fall to the USEPA.

At this time, USEPA has not specified any minimum requirements for a "qualified" operator. Therefore, all requirements originate at the State level.

Public Notification Requirements

The SDWA Amendments required USEPA to amend the existing public notification laws within 18 months of the passage of the amendments. On 28 October 1987, USEPA finalized its amendments to the public notification requirements.

A good reference guide is *General Public Notification for Public Water Systems*, Publication 570/9-89-002 (USEPA Office of Water, September 1989). This publication is available from regional USEPA representatives.

Classes of Violations

There are two classifications of violations for which public notification is required: Tier 1 and Tier 2. Tier 1 violations are more serious than Tier 2 violations. Table 14 shows these classifications. Tier 1 violations are further subdivided as acute or nonacute violations. Acute violations are those that pose an acute risk to human health. The following are defined as acute violations according to 40 CFR 141.32(a)(1)(iii):

1. Any violations specified by the State as posing an acute risk to health

2. Violation of the MCL for nitrate

3. Violation of the MCL for total coliforms when fecal coliforms or *E. coli* are present in the water distribution system, and

4. Occurrence of a waterborne disease outbreak in an unfiltered system.

Several requirements pertain to all Tier 1 violations. The PWS must give notice in a daily newspaper of general circulation as soon as possible, and no later than 14 days after the violation. If the area is not served by a daily newspaper, a weekly newspaper may be used. Also, the PWS must give notice by mail delivery (by direct mail or with the water bill) no later than 45 days after the violation or failure. The system must continue to give notice every 3 months while the violation continues. The State may waive the requirement for mail notification if the violation is cleared up within 45 days.

If an area served by a CWS is not served by a local daily or weekly paper, notice must be served by hand delivery or conspicuous and continuous posting. A noncommunity PWS may use hand delivery

Table 14

Classification of Violations for Public Notification

Tier 1	Tier 2
1. Failure to comply with an MCL	1. Failure to comply with monitoring requirements
2. Failure to comply with a prescribed treatment technique	2. Failure to comply with a testing procedure prescribed by a NPDWR
3. Failure to comply with a variance or exemption schedule	3. Operating under a variance or exemption

or posting in lieu of requirements for newspaper publication and mail delivery. In both cases notice must begin as soon as possible, and at least within 48 hours. Notice must continue as long as the violation exists, and must be repeated every 3 months.

For acute Tier 1 violations, the PWS must provide notice to local radio and television stations no later than 72 hours after the violation in addition to the other requirements discussed above.

For Tier 2 violations, notice must be given within 3 months of the violation or a variance or exemption must be granted and published in a newspaper of general circulation. Notice must be repeated every 3 months by mail delivery (either water bill or direct mail). If a community water system is not served by a daily or weekly paper of general circulation, notice must be given by hand delivery or conspicuous posting within 3 months of the violation. Posting must continue or hand delivery must be repeated every 3 months as long as the violation exists. A noncommunity water system may give notice within 3 months of violation by hand delivery or conspicuous posting in lieu of publication in a local newspaper. Again, posting must continue and hand delivery must be repeated every 3 months while the violation exists.

Mandatory Language

A public notice must include mandatory health effects language specified by USEPA for both MCL violation notification and notification of any exemptions or variances granted. Each regulated contaminant has a few paragraphs. The appendices pertaining to each rule include the mandatory language.

As well as including mandatory language, the notice must be clear and readily understandable, i.e., must not include unduly technical language, must not contain unduly small print or other characteristics that "frustrate the purpose of the notice."

Each notice must contain the telephone number of the owner, operator, or designee of the PWS as a source of additional information. Where appropriate, the notice must be multilingual.

Other items that must be included in the notice are:

1. Description of the pertinent regulation

2. A clear statement of the health significance of the violation

3. Description of any precautions the customer should take until the violation is corrected, or a clear statement that no precautionary actions are required

4. Description of action being taken by the water system to correct the problem.

New Enforcement Possibilities for USEPA

The SDWA amendment made several changes to the methods USEPA could use to enforce the regulations. First, the process by which USEPA could take action against water suppliers in States that have primary enforcement responsibility has been streamlined. Second, if a State does not take action against a water supplier within 30 days after USEPA has notified the State and water supplier of a violation, the USEPA must issue a compliance order or institute judicial action. Third, the bill provides an administrative order authority to the USEPA. Fourth, the maximum civil penalty is increased from $5000 a day to $25,000 a day. Finally, the requirement that violations be willful for civil penalties to be assessed is eliminated.

Variances and Exemptions

The State may issue a variance if it determines that a system cannot meet the MCL, even with application of the best available technology. However, the State cannot issue a variance if an unreasonable risk to health exists. When a variance is issued, the State must at the same time dictate a compliance and implementation schedule.

The State may issue an exemption from any MCL or treatment technique if (1) due to compelling reasons (which may include economic factors), the system is unable to comply, (2) the system was in operation on the effective date of the MCL or treatment technique, and (3) the exemption will not result in an unreasonable health risk. When an exemption is issued, the State must at the same time dictate a compliance and implementation schedule.

Sampling and Monitoring for Compliance

Routine Sampling Frequencies

There are different monitoring requirements for each contaminant group covered by SDWA. Specific requirements depend on whether the system uses surface water or ground water, and on the number of people served. Sampling is being phased in over a 4 year period, with larger systems monitoring first. Small systems—those serving fewer than 3300 people—should have started sampling as of January 1991. One sample per quarter must be taken from each source (each well or treatment plant) for a period of 1 year. This is considered the initial sample. If the system uses groundwater that the regulatory agency determines is not vulnerable to VOC contamination, and if no VOCs are detected in the first sample, then the agency may allow the system to collect only the first quarter's sample rather than all four.

Noncommunity water systems are only required to monitor for coliform bacteria, turbidity, and nitrate (an inorganic contaminant). The required sampling frequencies are the same as for community systems, except that coliform samples are only required quarterly. However, sampling requirements may be reduced by the regulatory agency upon completion of a sanitary survey.

In addition to monitoring for the regulated chemicals, a system must monitor for sodium, and the results must be reported to the regulatory agency. There is no enforceable level for sodium—this requirement is for purposes of monitoring and reporting. Also, the system must be sampled at least once for corrosivity characteristics, including pH, calcium, hardness, alkalinity, temperature, total dissolved

solids, and calculation of the Langlier Index. As for sodium, there are no enforceable levels for these parameters—levels are sampled solely for purposes of monitoring and reporting.

Table 15, *which applies to community water systems only*, lists the sampling frequencies for each type of contaminant covered by SDWA.

Requirements for specific contaminants can be found in the EPA publication *The Safe Drinking Water Act—A Pocket Guide to the Requirements for the Operators of Small Water Systems* (USEPA Region 9, San Francisco, September 1991).

Location of Sampling Points

Most samples must be collected at points that represent the quality of water in the distribution system, but there are some variations. Table 16 lists the locations of the sampling points for major types of contaminants.

Generally, the samples must be "fully flushed," meaning that the water should run for a sufficient length of time to represent water in the main line rather than in a service line or plumbing system.

Sampling Procedures

Listed below are several variables that will affect sampling procedures:

- Type of container—some samples must be collected in glass containers, but others can be collected in plastic. Most labs will provide properly prepared containers.

- Volume of water required—different volumes are required for each type of analysis, ranging from 100 ml for a coliform sample to 1 gallon for some radiochemical samples.

- Preservation—some samples must be kept cold, while others can be delivered to the lab at room temperature. Additionally, some samples must be acidified.

- Filling the container—some sample containers, such as those used for VOCs, must be filled to the top with no air space, but others need not be.

Table 15

Sampling Frequencies for the Major Contaminant Types

	Surface Water	Groundwater
Inorganics	annually	every 3 years
Synthetic Organics	every 3 years	optional
Radionuclides	every 4 years	every 4 years
Total Coliform	monthly	monthly
Turbidity	daily	not required
Volatile Organics	every 5 years	every 5 years

Table 16

Location of Sampling Points for Major Contaminant Types

Contaminant or Type	Location
Inorganics	distribution system
Synthetic Organics	distribution system
Radionuclides	distribution system
Turbidity	leaving plant, entering distribution system
Coliform	distribution system
Volatile Organics	each source, entering distribution system

- Hold times—the maximum allowable time between sample collection and analysis can range from 1 day, for a coliform sample, to 1 year, for a radiochemical sample. Sample results are not valid if the specified hold time has been exceeded.

Before starting to sample, it is a good idea to contact a certified laboratory and ask for a copy of the applicable sampling procedures and instructions. The regulatory agency can provide a list of area labs that are certified to run the tests.

5 CONCLUSION

With the 1986 SDWA Amendments, Congress directed USEPA to step up its efforts toward formally establishing drinking water standards. With these Amendments, Congress explicitly required USEPA to (1) regulate 83 specific contaminants and (2) accelerate the timetable for establishing the regulations.

USEPA is addressing Congress' list of 83 contaminants through a series of rules. Six of those rules have been finalized: the Fluoride Rule, the Volatile Organic Chemicals Rule, the Total Coliform Rule, the Surface Water Treatment Rule, the Synthetic Organic Chemicals and Inorganic Chemicals Rule (Phase II), and the Lead and Copper Rule. One rule–the Synthetic Organic Chemicals and Inorganic Chemicals Rule (Phase V) has been proposed but not finalized. Additionally, several rules are anticipated but have not yet been proposed: the Radionuclides Rule, the Disinfection/Disinfection Byproducts Rule (which has been published as a "Strawman" rule, the Groundwater Disinfection Rule, and a revised Arsenic Rule. These rules address health effects due to trace organics and call for more rigorous bacteriological control.

Army installations will have to meet many of the challenges facing the water industry in general as well as a few additional ones. Older Army water treatment plants will not have the space or the flexibility to adapt to many of the new regulations. Treatment plants will have to operate more efficiently while retaining the flexibility to serve populations of widely fluctuating size.

Army installations that purchase water may encounter questions of responsibility for problems with lead contamination and residual disinfectant content. Range wells serving a significant population for a short period of time may require treatment of some kind.

Several of the rules (e.g., SWTR and D/DBP) overlap in scope. SWTR requires a minimum level of disinfection while the anticipated D/DBP rule will limit the level of disinfection byproducts allowed. As future regulations are finalized, complying with all regulations will become more difficult. To comply with the new rules in this increasingly complicated regulatory environment, water treatment plants throughout the drinking water industry will have to change the way they operate. Careful operation of a well designed treatment plant to precise specifications will be the only way to meet the mandated contaminant levels. Army water treatment plants will have to review their current operation procedures, then adapt to the new regulations. Adapting to the new regulations will require older plants to optimize the operation of existing facilities where possible and retrofit with newer technologies where necessary.

Changes in monitoring requirements will require a response from all Army water treatment plants. The most important source of specific information on the new monitoring requirements is the State authority.

For most contaminants regulated under the new rules, USEPA defines a Best Available Technology, or BAT, for removal. For SOCs, however, Congress–not USEPA–mandated that GAC would be the BAT. Installation of a BAT is not required unless a system is applying for a variance or exemption from a mandated contaminant level.

The new Lead and Copper Rule requires corrosion control for (1) all systems not meeting the USEPA-specified action levels for lead and copper and (2) all systems serving more than 50,000 people. Many Army-operated water systems throughout the United States will have to begin corrosion control studies. Corrosion control options will include pH adjustment, introduction of corrosion inhibitors, and carbonate system adjustment.

In general, the SDWA Amendments will continue to offer technical and administrative challenges to Army water treatment plants, as they will to the drinking water industry as a whole.

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APPENDIX A: Volatile Organic Chemicals Rule

I. GENERAL REQUIREMENTS

A. Water Systems Affected. The requirements of the VOCs Rule apply to community and non-community nontransient water systems.

B. Maximum Contaminant Level Goals and Maximum Contaminant Levels. Table A1 shows the MCLGs and MCLs finalized by the VOCs Rule. Compliance with the MCLs is based on the results of a running annual average of quarterly samples for each sampling location. A running annual average is an average of the four most recent quarterly samples. If any one sample result would cause the running average to exceed the MCL, the system is out of compliance immediately. For systems taking only one sample per location, compliance is based on that one sample.

C. Monitoring. All community and nontransient, noncommunity water systems must monitor for the eight regulated and 51 unregulated contaminants. The basic requirement is one sample set per quarter. The requirements are explained in detail in the section below on monitoring requirements. Because of a January 1991 USEPA proposal for a standardized monitoring framework for organic chemicals, the monitoring requirements for this rule may be amended. The amended monitoring program will affect the repeat monitoring requirements only, not the initial monitoring requirements.

II. BEST AVAILABLE TECHNOLOGY

Packed-tower aeration has been designated BAT for all compounds under the VOCs Rule. Granular activated carbon is also designated as BAT, except for vinyl chloride.

III. MONITORING REQUIREMENTS

For the purposes of this discussion, a "sample" is a single sample taken at one site in the distribution system. A "sample set" is the total number of required samples taken by one system covering the entire

Table A1

VOC (Phase I) Regulations

Compound	MCLG mg/l	MCL mg/l
Benzene	zero	0.005
Carbon Tetrachloride	zero	0.005
para-Dichlorobenzene	0.075	0.075
1,2-Dichloroethane	zero	0.005
1,1-Dichloroethylene	0.007	0.007
1,1,1-Trichloroethane	0.20	0.20
Trichloroethylene	zero	zero
Vinyl Chloride	zero	0.002

distribution system. Four sample sets are required per year. A "sample sequence" is one year of quarterly sample sets.

A. Proposed Regulations. Since the VOCs Rule was finalized, the EPA has introduced a standardized monitoring framework for volatile organic chemicals, synthetic organic chemicals, and inorganic chemicals. On 30 January 1991, EPA proposed changes to the original VOCs Rule to make it consistent with the new framework, and to reduce the complexity of the monitoring requirements. EPA expects to finalize this rule by July 1991. A description of this new framework is included in Chapter 3.

For the eight VOCs regulated by the original VOCs Rule, the new monitoring framework would only apply to the **repeat** monitoring requirements, not the initial monitoring requirements. All systems should have completed their initial monitoring requirements under the existing regulation by January 1992. The proposed regulation would require all systems to conduct repeat monitoring on an annual basis beginning in January 1993.

B. Existing Regulations

1. General Requirements. All community and noncommunity systems must monitor for regulated compounds in Table A1 and some of the unregulated compounds in Table A2. In Table A2, List 1 represents compounds that must be monitored by all systems. List 2 represents compounds that must be monitored by systems whose water supply is determined to be vulnerable to possible contamination. Vulnerability is determined by the State. List 3 represents compounds that may be monitored at the discretion of the State. Monitoring consists of one initial sample set, and then repeat sample sets (or sequences) as indicated. Summaries of the requirements are shown in Figure A1 and Figure A2.

Vulnerability is defined as a system's susceptibility to contamination by organic chemicals. For each public water system, the State must determine its vulnerablility based on an assessment of four factors:

a) Previous monitoring results
b) Number of persons served by the water system
c) Proximity of a smaller system to a larger system
d) Proximity to commercial or industrial use, disposal, or storage of volatile synthetic organic chemicals.

In addition, a system is judged to be vulnerable for a period of 3 years after any positive measurement of one or more contaminants in List 1.

2. Monitoring for Regulated Contaminants. Regulated contaminants are shown in Table A1.

a) Groundwater Systems. Figure A1 shows a diagram of the VOC monitoring requirements for groundwater.

(1) Location of Samples. Groundwater systems must sample at points of entry to the distribution system representative of each well after any application of treatment. Composite samples of up to five sampling points are allowed. Compositing of samples must be done in the laboratory by the procedures described in 40 CFR 141.24(g)(7).

(2) Frequency of Sampling. Sampling must be conducted at the same location(s) or more representative location(s) every 3 months for 1 year (i.e., four sample sets

Table A2

Additional Contaminants for Monitoring

List 1	List 2	List 3
Bromobenzene	Ethylene dibromide (EDB)	Bromochloromethane
Bromodichloromethane	1,2-Dibromo-3-chloropropane	*n*-Butylbenzene
Bromoform		Dichlorodifluoromethane
Bromomethane		Fluorotrichloromethane
Chlorobenzene		Hexachlorobutadiene
Chlorodibromomethane		Isopropylbenzene
Chloroethane		*p*-Isopropyltoluene
Chloroform		Naphthalene
Chloromethane		*n*-Propylbenzene
o-Chlorotoluene		sec-Butylbenzene
p-Chlorotoluene		tert-Butylbenzene
Dibromomethane		1,2,3-Trichlorobenzene
m-Dichloromethane		1,2,4-Trichlorobenzene
o-Dichlorobezene		1,2,4-Trimethylbenzene
trans-1,2-Dichloroethylene		1,3,5-Trimethylbenzene
cis-1,2-Dichloroethylene		
Dichloromethane		
1,1-Dichloroethane		
1,2-Dichloropropane		
1,3-Dichloropropane		
2,2-Dichloropropane		
1,1-Dichloropropene		
1,3-Dichloropropene		
Ethylbenzene		
Styrene		
1,1,1,2-Tetrachloroethane		
1,1,2,2-Tetrachloroethane		
Tetrachloroethylene		
1,1,2-Trichloroethane		
1,2,3-Trichloropropane		
Toluene		
p-Xylene		
o-Xylene		
m-Xylene		

must be taken during the course of 1 year). If VOCs are **not** detected in the first sample set, the State **may** reduce the sampling frequency as below:

(a) When VOCs are not detected in the first sample set (or any subsequent samples that may be taken) and the system is "not vulnerable" as defined by the State, monitoring may be reduced to one sample set repeated every 5 years.

(b) When VOCs are not detected in the first sample set (or any subsequent samples that may be taken), but the system is "vulnerable" as defined by the State, monitoring may be reduced to one sample set every 5 years for systems with less than 500 connections or one sample set every 3 years for systems with more than 500 connections.

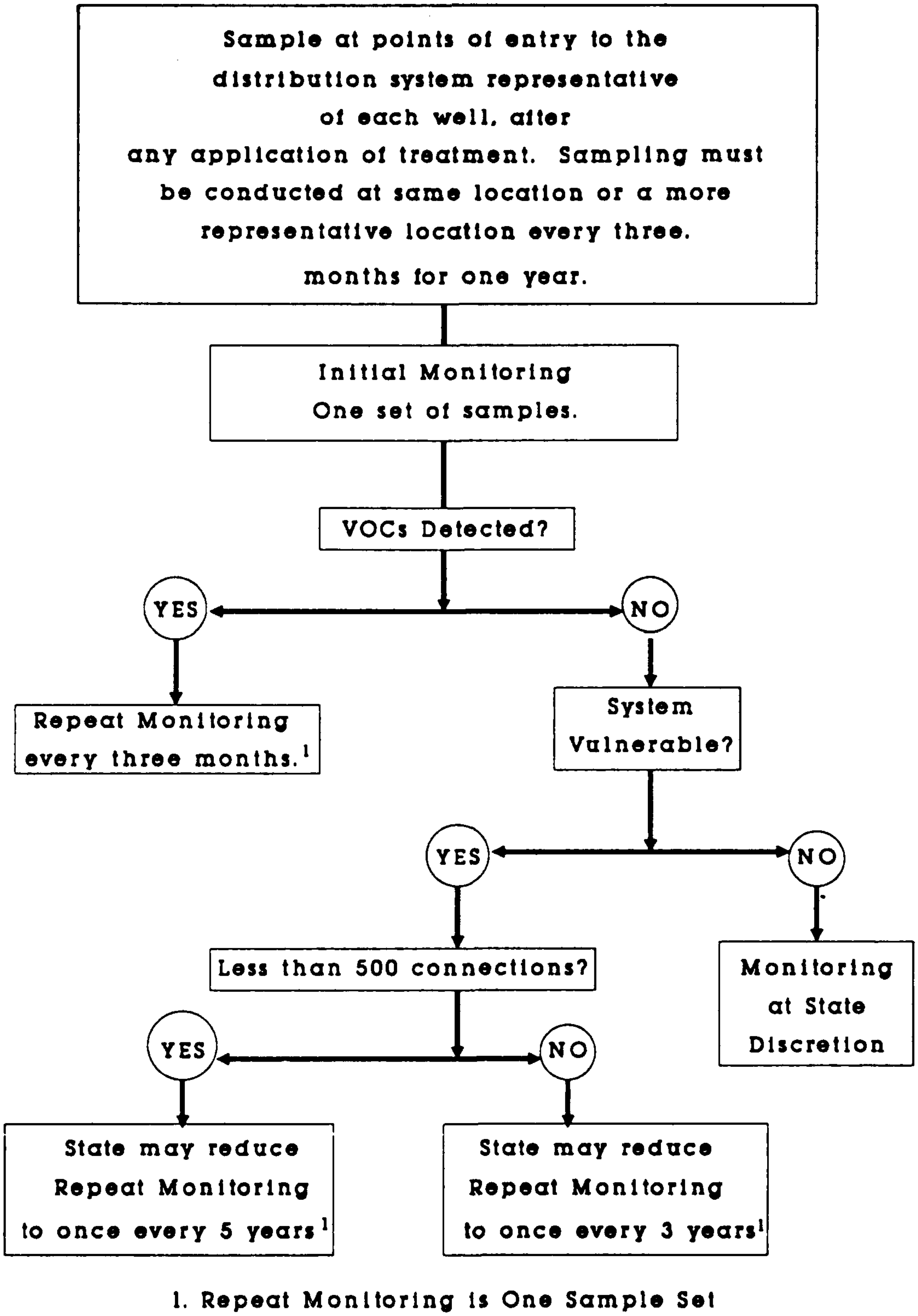
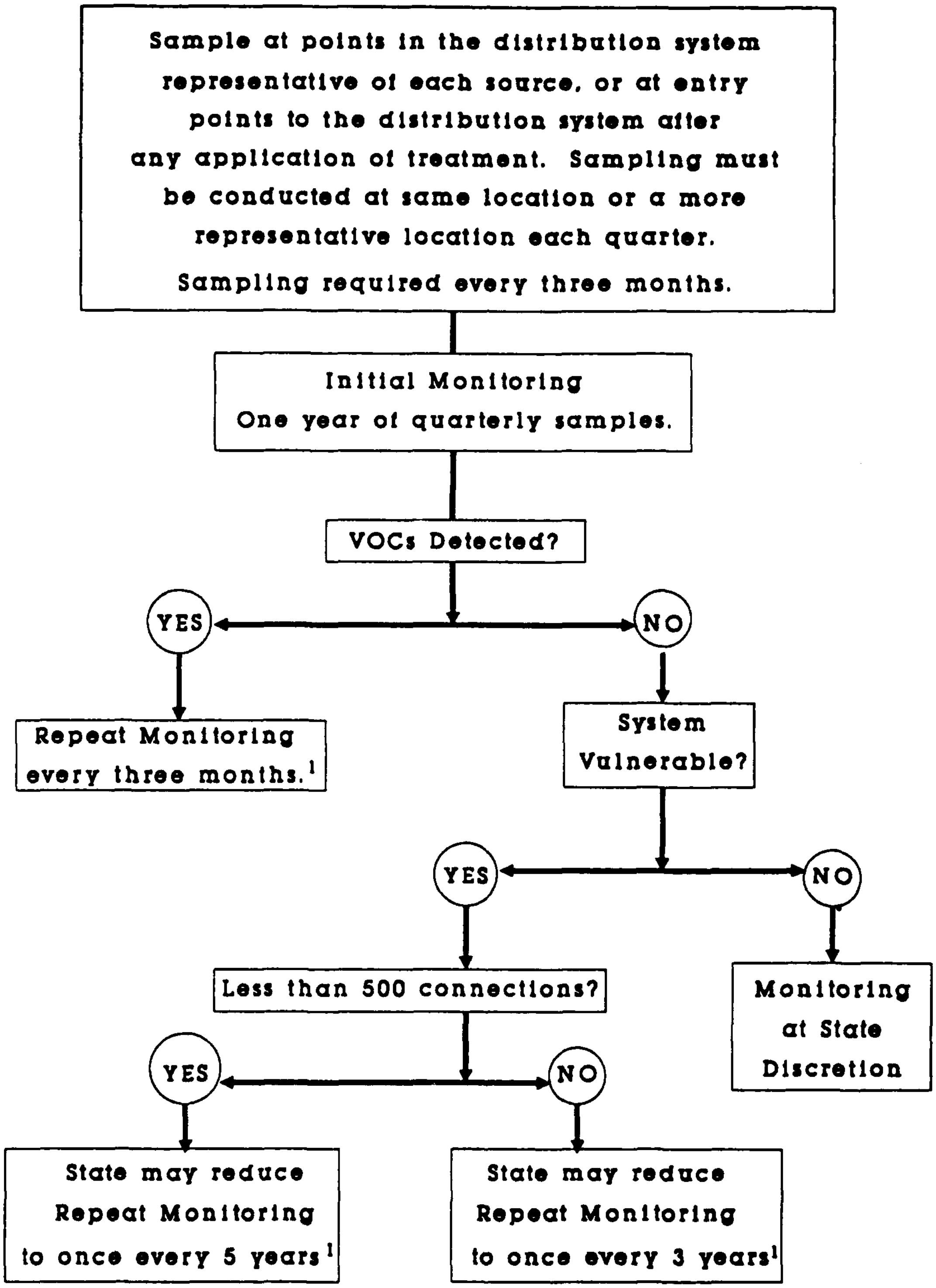


Figure A1. VOC Monitoring Requirements for Groundwater.



1. Repeat Monitoring is Year of Quarterly Samples

Figure A2. VOC Monitoring Requirements for Surface Water.

b) **Surface Water Systems.** Figure A2 shows a diagram of the monitoring requirements for surface waters.

(1) **Location of Samples.** Surface water systems must sample at points in the distribution system representative of each source or at entry points to the distribution system after any application of treatment. Composite samples of up to five sampling points are allowed. Compositing of samples must be done in the laboratory by the procedures described in CFR 141.24(g)(7).

(2) **Frequency of Sampling.** Each source must be sampled every 3 months. Sampling must be conducted at the same location or a more representative location each quarter. An initial monitoring of 1 year of quarterly sample sets (sample sequence), is required of all systems. If VOCs are detected in the initial sample sequence, sample sets must be repeated every 3 months. If VOCs are **not** detected, the following conditions apply:

(a) If VOCs are not detected in the initial sampling sequence, and the system is judged to be "not vulnerable," monitoring is required only at State discretion.

(b) If VOCs are not detected in the initial sampling sequence but the system is judged to be "vulnerable," monitoring may be reduced to one sampling sequence every 3 years for systems with more than 500 connections, or to one sampling sequence every 5 years for systems with less than 500 connections.

c) **Confirmation Samples.** The State or EPA may require confirmation samples for positive or negative results. If a confirmation sample is required by EPA or the State, then the sample result(s) should be averaged with the first sampling result and used for determining compliance. States have discretion to delete results of obvious sampling errors from this calculation.

d) **Multiple Sources.** If the system draws water from more than one source and those sources are combined before distribution, the system must sample at an entry point to the distribution system during normal operating conditions.

3. **Vinyl Chloride Sampling.** Vinyl chloride monitoring is required only for groundwater systems, and only if vinyl chloride precursors are found. Since vinyl chloride is only slightly soluble in water, it is not commonly found in surface water. If one or more of the following compounds are detected, the analysis for vinyl chloride is required at each distribution or entry point at which they were found:

- Trichloroethylene
- Tetrachloroethylene
- 1,2-Dichloroethane
- 1,1,1-Trichloroethane
- *cis*-1,2-Dichloroethylene
- *trans*-1,2-Dichloroethylene
- 1,1-Dichloroethylene.

Surface water systems may be required to analyze for vinyl chloride at the discretion of the State.

4. **Monitoring for Unregulated Contaminants.** Unregulated compounds are shown in Table A2.

a) Groundwater Systems.

(1) Location of Samples. Groundwater systems must sample at points of entry to the distribution system representative of each well after any application of treatment.

(2) Frequency of Sampling. The minimum number of samples is one sample per entry point to the distribution system.

b) Surface Water Systems.

(1) Location of Samples. Surface water systems must sample at points in the distribution system representative of each source or at entry points to the distribution system after any application of treatment.

(2) Frequency of Sampling. The initial sampling sequence must be 1 year of quarterly samples.

c) Repeat Monitoring. Repeat monitoring must be performed every 5 years (i.e., groundwater systems must take one sample set and surface water systems must take one sample sequence). The list of unregulated contaminants that will be monitored is expected to change.

5. Composite Samples. A State or individual public water system may choose to composite up to five samples from one or more public water systems. Compositing samples is to be done in the laboratory according to the procedures listed below.

a) Compositing Samples Prior to Gas Chromatography (GC) Analysis.

(1) Add 5 ml or equal larger amounts of each sample (up to 5 samples are allowed) to a 25 ml glass syringe. Special precautions must be made to maintain zero headspace in the syringe.

(2) The samples must be cooled at 4°C during this step to minimize volatilization losses.

(3) Mix well and draw out a 5 ml aliquot for analysis.

(4) Follow sample introduction, purging, and desorption steps described in whatever method is being used. the method.

(5) If less than five samples are used for compositing, a proportionately smaller syringe may be used for part (1), but the 5 ml aliquot must be maintained.

b) Compositing Samples Prior to Gas Chromatography/Mass Spectrophoto-metry (GC/MS) Analysis.

(1) Inject 5 ml or equal larger amounts of each aqueous sample (up to five samples are allowed) into a 25 ml purging device using the sample introduction technique described in whatever method is being used.

(2) The total volume of the sample in the purging device must be 25 ml.

(3) Purge and desorb as described in the method.

IV. PUBLIC NOTIFICATION

A. General Requirements. All general public notification requirements apply. Refer to Chapter 4 for a description of those requirements.

B. Mandatory Language. The VOCs Rule requires that the following language must be used for the noted compounds:

1. 1,1-Dichloroethylene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that 1,1-dichloroethylene is a health concern at certain levels of exposure. This chemical is used in industry and is found in drinking water as a result of the breakdown of related solvents. The solvents are used as cleaners and degreasers of metals and generally get into drinking water by improper waste disposal. This chemical has been shown to cause liver and kidney damage in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause adverse effects in laboratory animals also may cause adverse health effects in humans who are exposed at lower levels over long periods of time. EPA has set the enforceable drinking water standard for 1,1-dichloroethylene at 0.007 parts per million (ppm) to reduce the risk of these adverse health effects which have been observed in laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe."

2. 1,1,1-Trichloroethane. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that 1,1,1-Trichloroethane is a health concern at certain levels of exposure. This chemical is used as a cleaner and degreaser of metals. It generally gets into drinking water by improper waste disposal. This chemical has been shown to damage the liver, nervous system, and circulatory system of laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Some industrial workers who were exposed to relatively large amounts of this chemical during their working careers also suffered damage to the liver, nervous system, and circulatory system. Chemicals which cause adverse effects among exposed industrial workers and in laboratory animals also may cause adverse health effects in humans who are exposed to lower levels over long periods of time. EPA has set the enforceable drinking water standard for 1,1,1-Trichloroethane at 0.2 parts per million (ppm) to protect against the risk of these adverse health effects which have been observed in humans and laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe."

3. 1,2-Dichloroethane. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that 1,1-dichloroethane is a health concern at certain levels of exposure. This chemical is used as a cleaning fluid for fats, oils, waxes, and resins. It generally gets into drinking water by improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the enforceable drinking water standard for 1,1-dichloroethane at 0.005 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe."

4. Benzene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that benzene is a health concern at certain levels of exposure. This chemical is used as a solvent and degreaser of metals. It is also a major component of gasoline. Drinking water contamination generally results from leaking underground gasoline and petroleum tanks or improper waste disposal. This chemical has been associated with significantly increased risks of leukemia among certain industrial workers who were exposed

to relatively large amounts of this chemical during their working careers. This chemical has also been shown to cause cancer in laboratory animals when the animals are exposed at high levels over their lifetimes. Chemicals that cause increased risk of cancer among exposed industrial workers and in laboratory animals also may increase the risk of cancer in humans who are exposed to lower levels over long periods of time. EPA has set the enforceable drinking water standard for benzene 0.005 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in humans and laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe."

5. **Carbon Tetrachloride**. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that carbon tetrachloride is a health concern at certain levels of exposure. This chemical was once a popular household cleaning fluid. It generally gets into drinking water by improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the enforceable drinking water standard for carbon tetrachloride at 0.005 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe."

6. **para-Dichlorobenzene**. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that para-dichlorobenzene is a health concern at certain levels of exposure. This chemical is a component of deodorizers, mothballs, and pesticides. It generally gets into drinking water by improper waste disposal. This chemical has been shown to cause liver and kidney damage in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause adverse effects in laboratory animals also may cause adverse health effects in humans who are exposed at lower levels over long periods of time. EPA has set the enforceable drinking water standard for para-dichlorobenzene at 0.075 parts per million (ppm) to reduce the risk of these adverse health effects which have been observed in laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe."

7. **Trichloroethylene**. The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that trichloroethylene is a health concern at certain levels of exposure. This chemical is a common metal cleaning and dry cleaning fluid. It generally gets into drinking water by improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set forth the enforceable drinking water standard for trichloroethylene at 0.005 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe."

8. **Vinyl Chloride**. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that vinyl chloride is a concern at certain levels of exposure. This chemical is used in industry and is found in drinking water as a result of the breakdown of related solvents. The solvents are used as cleaners and degreasers of metals and generally get into drinking water by improper waste. This chemical has been associated with significantly increased risks of cancer among certain industrial workers who were exposed to relatively large amounts of this chemical during their working careers. This chemical has also been shown to cause cancer in laboratory animals when the animals are exposed at high levels over their

lifetimes. Chemicals that cause increased risk of cancer among exposed industrial workers and in laboratory animals also may increase the risk of cancer in humans who are exposed of lower levels over long periods of time. EPA has set the enforceable drinking water standard for vinyl chloride 0.002 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in humans and laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe."

V. VARIATIONS AND EXEMPTIONS

Variances - Possible
Exemptions - Possible

VI. ANALYTICAL METHODS

A. **General Requirements**. Analyses must be conducted by laboratories that have received conditional approval by the EPA or the State.

1. **Analytical Methods**. The following approved methods are contained in *Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water*, September 1986, available from Environmental and Support Laboratory (EMSL), EPA, 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

2. **Method 502.1**—Volatile Halogenated Organic Chemicals in Water by Purge and Trap Gas Chromatography.

3. **Method 503.1**—Volatile Aromatic and Unsaturated Organic Compounds by Purge and Trap Gas Chromatography

4. **Method 524.1**—Volatile Organic Chemicals in Water by Purge and Trap Gas Chromatography/Mass Spectrophotometry

5. **Method 524.2**—Volatile Organic Chemicals in Water by Purge and Trap Gas...Capillary Column...Chromatography/Mass Spectrophotometry

6. **Method 502.2**—Volatile Organic Chemicals in Water by Purge and Trap Capillary Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series

7. **Method 504—1,2**-Dibromomethane and 1,2-Dibromo-3-chloropropane in Water by Microextraction and Gas Chromatography

VII. TIMETABLE

A. **Proposed Rule (RMCLs)**. 12 June 1984

B. **Final rule (RMCLs)**. 13 November 1985

C. **Proposed Rule (MCLs)**. 13 November 1985

D. **Final rule**. 8 July 1987

E. **Final rule Correction**. 1 July 1988

F. Proposed Changes. 30 January 1991

G. Compliance Dates. 9 January 1989—VOCs Rule became effective.

H. Monitoring Dates. Table A3 shows the deadlines for starting and finishing the initial monitoring.

Table A3

Deadlines for Initial VOC Monitoring

Size of Population Served	Begin Date	End Date
More than 10,000	1 January 1988	31 December 1988
3300 - 10,000	1 January 1989	31 December 1989
Less than 3300	1 January 1991	31 December 1991

APPENDIX B: Fluoride Rule

I. GENERAL REQUIREMENTS

A. Water Systems Affected. The Fluoride Rule affects all community water systems.

B. Maximum Contaminant Level Goals and Maximum Contaminant Levels. MCL—4.0 mg/l; MCLG—4.0 mg/l; SMCL—(a)2.0 mg/l (Figure B1).

II. BEST AVAILABLE TECHNOLOGY

Two technologies have been designated BAT for fluoride removal: activated alumina adsorption and reverse osmosis.

III. MONITORING REQUIREMENTS

A. Surface Water Systems. Surface water sources must sample every year. These samples must be taken at each entry point into the distribution system. If the MCL is exceeded the system must report to the State within 1 week and take three additional samples at the same sampling point within 1 month. If the average of those four samples exceeds the maximum contaminant level, the system shall notify the State and give proper public notification. The State will designate a monitoring frequency to continue until two successive samples meet the MCL or other State action takes effect.

B. Groundwater Systems. Groundwater systems must sample every 3 years. These samples must be taken at entry points into the distribution system. If more than one source is used and these sources are combined before distribution, samples must be taken during normal operating conditions.

IV. PUBLIC NOTIFICATION

A. General Requirements. All general public notification requirements apply. In addition, a yearly notice of SMCL exceedance is required.

B. Mandatory Language. The yearly notice required for SMCL exceedance must contain the following language, including the language necessary to insert at the superscript Arabic numerals near the beginning and end of the notice.

Dear User,

The U.S. Environmental Protection Agency requires that we send you this notice on the level of fluoride in your drinking water. The drinking water in your community has a fluoride concentration of[1] milligrams per liter (mg/l).

Federal regulations require that fluoride, which occurs naturally in your water supply, not exceed a concentration of 4.0 mg/l in drinking water. This is an enforceable standard called a Maximum Contaminant Level (MCL), and it has been established to protect the public health. Exposure to drinking water levels above 4.0 mg/l for many years may result in some cases of crippling skeletal fluorosis, which is a serious bone disorder.

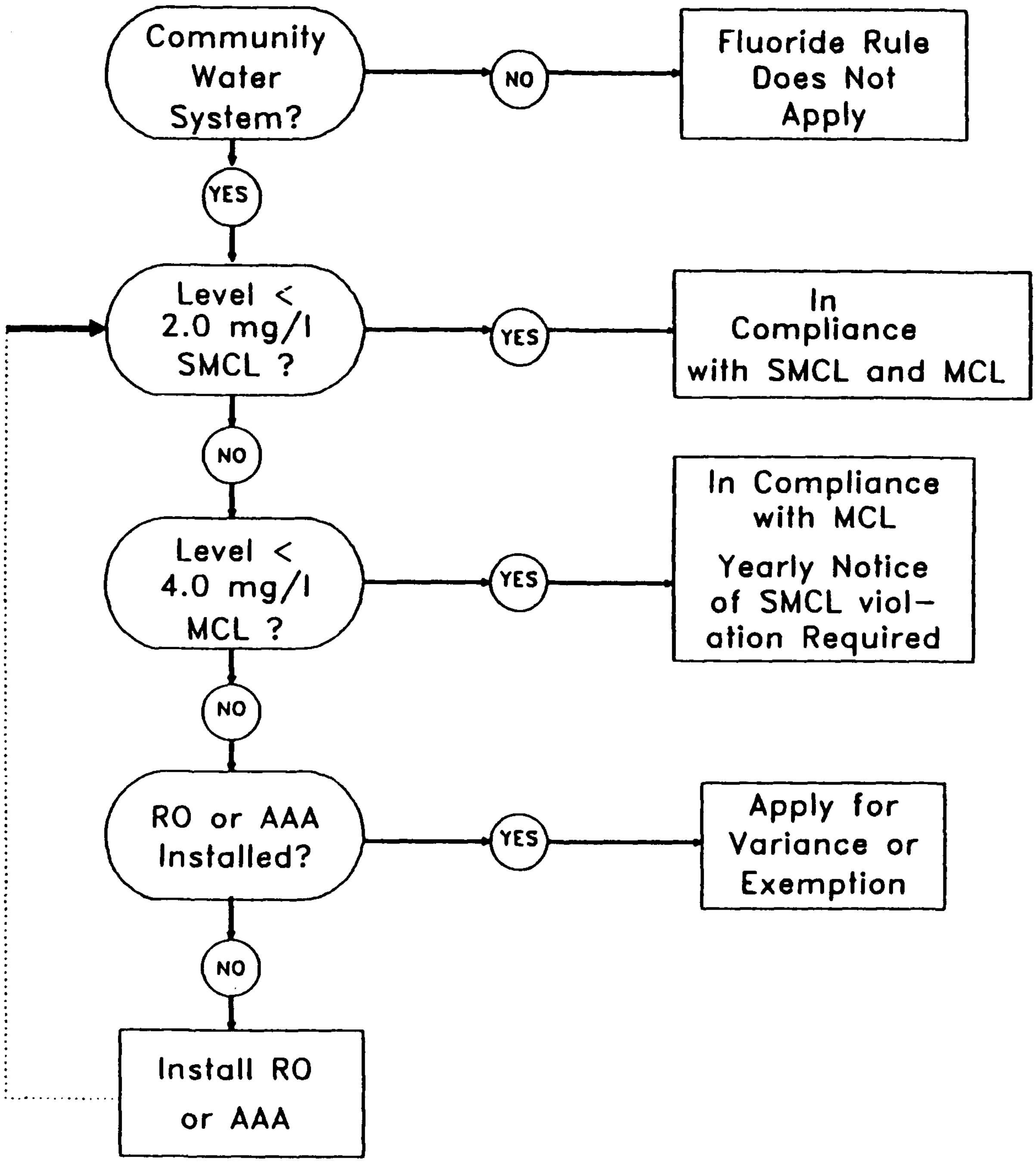


Figure B1. Fluoride Rule Applicability .

Federal law also requires that we notify you when monitoring indicates that the fluoride in your drinking water exceeds 2.0 mg/l. This is intended to alert families about dental problems that might affect children under nine years of age. The fluoride concentration in your water exceeds this federal guideline.

Fluoride in children's drinking water at levels of approximately 1 mg/l reduces the number of dental cavities. However, some children exposed to levels of fluoride greater than about 2.0 mg/l may develop dental fluorosis. Dental fluorosis is a brown staining and/or pitting of the *permanent* teeth.

Because dental fluorosis occurs only when *developing* teeth (before they erupt from the gums) are exposed to elevated fluoride levels, households without children are not expected to be affected by this level of fluoride. Families with children under the age of nine are encouraged to seek other sources of drinking water for their children to avoid the possibility of staining and pitting.

Your water supplier can lower the concentration of fluoride in your water so that you will still receive the benefits of cavity prevention while the possibility of stained and pitted teeth is minimized. Removal of fluoride may increase your water costs. Treatment systems are also commercially available for home use. Information on such systems is available at the address given below. Low fluoride bottled drinking water that would meet all standards is also commercially available.

"For further information, contact [2] at your water system."

[1]—PWS shall insert the compliance result which triggered notification under this Part.
[2]—PWS shall insert the name, address, and telephone number of a contact person at the PWS.

V. VARIANCES AND EXEMPTIONS

Both variances and exemptions are possible for the Fluoride Rule.

VI. ANALYTICAL METHODS

The following methods are approved for the analysis of fluoride in drinking water:

A. **Method 413B**—Ion-selective electrode or Automated ion selected electrode

B. **Method 413C**—Colorimetric SPADNS

C. **Method 413E**—Complexone.

VII. TIMETABLE

A. **Proposed Rules**. MCLG—14 May 1985; MCL—14 November 1985; SMCL—14 November 1985.

B. **Final rules**. MCLG—14 November 1985; MCL—2 April 1986; SMCL—2 April 1986.

C. **Compliance Dates.** 2 October 1987—MCL effective.

D. **Current Status**. Under review.

APPENDIX C: Surface Water Treatment Rule

SWTR regulates filtration, disinfection, turbidity, *Giardia Lamblia*, viruses, *Legionella*, and heterotrophic bacteria.

VIII. GENERAL REQUIREMENTS

A. Water Systems Affected. SWTR applies to all public water systems (both community and noncommunity) using surface water or groundwater under the direct influence of surface water.

B. Treatment Technique. Required treatment is disinfection and filtration to 3 log (99.9 percent) removal of *Giardia* and 4 log (99.99 percent) removal of viruses.

C. MCLGs. *Giardia*—0; Viruses—0; *Legionella*—0.

D. Operating Criteria. Filtered water turbidity must at no time exceed 5 nephelometric turbidity units (NTU) and must meet the following turbidity limits in 95 percent of the measurements taken each month:

- Conventional treatment or direct filtration: 0.5 NTU
- Slow sand filtration: 1 NTU
- Diatomaceous earth filtration: 1 NTU
- Other technologies: 1 NTU.

Residual disinfectant entering the distribution system cannot be less than 0.2 mg/l for more than 4 hours. Residual disinfectant anywhere in the distribution system cannot be undetectable in more than 5 percent of the samples taken in a month. An HPC bacteria level of 500 or fewer colonies is considered a detectable residual.

II. BEST AVAILABLE TECHNOLOGY

Conventional treatment (including coagulation, flocculation, sedimentation, rapid granular filtration, and disinfection).

III. MONITORING REQUIREMENTS

A. General Requirements. Measurements for pH, temperature, turbidity, and residual disinfectant concentrations must be performed by a party approved by the State. Measurements for total coliforms, fecal coliforms, and HPC must be conducted by a laboratory certified by the State to do such analyses. Until laboratory certification criteria are developed for the analysis of HPC and fecal coliform, any lab certified to perform total coliform tests will be deemed certified for HPC and fecal coliform analysis.

B. For systems providing filtration

1. Turbidity. Turbidity measurements must be performed on representative samples of the systems filtered water every 4 hours. A public water system may substitute continuous monitoring for grab samples if it validates the continuous measurement on a regular basis using a protocol approved by the State.

2. **Total Inactivation Ratio.** A water system that provides filtration does not have to monitor its total inactivation ratio, but the disinfection treatment must be sufficient to ensure that the total treatment processes attain the required removals.

3. **Residual Disinfectant Entering the Distribution System.** The residual disinfectant concentration of the water entering the distribution system must be monitored continuously, and the lowest value must be recorded each day. If the continuous monitoring equipment fails, grab-sample monitoring every 4 hours is allowed for up to 5 working days for equipment repair. Systems serving less than 3300 people may take grab samples in lieu of providing continuous monitoring on an ongoing basis at the frequencies shown in Table C1. Anytime the residual disinfectant concentration falls below 0.2 mg/l in a system using grab samples in lieu of continuous monitoring, the system must take a grab sample every 4 hours until the residual disinfectant is equal to or greater than 0.2 mg/l.

4. **Residual Disinfectant in the Distribution System.** The residual disinfectant concentration in the distribution system must be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled under the Total Coliform Rule. The State may allow a public water system that uses both a surface water source and a groundwater source under the influence of surface water, or a system that uses a surface water source and a groundwater source, to sample at other points if the State determines that such points are more representative of the treated water quality within the distribution system. HPC bacteria may be measured in lieu of disinfectant residual. This residual cannot be undetectable in more than 5 percent of the samples each month for any two consecutive months that the system serves water to the public.

C. For systems not providing filtration

1. **Fecal Coliform or Total Coliform.** Fecal coliform or total coliform density measurements must be performed on representative samples immediately before the first or only point of disinfectant application. The system must sample at the frequency shown in Table C2 each week it serves the public. For the system to continue to meet the criteria to avoid filtration, the fecal coliform concentration must be equal to or less than 20/100 ml, or the total coliform concentration must be equal to or less than 100/100ml. Also, one fecal coliform or total coliform density measurement must be made every day the system serves water to the public during which the turbidity of the source water exceeds 1 NTU. These samples count towards the weekly samples required under the total coliform rule.

Table C1

Chlorine Residual Grab Sample Frequency for System Serving Less Than 3300 People

Population Served	Samples/Day
< 500	1
501 to 1000	2
1001 to 2500	3
2501 to 3300	4

Table C2

Coliform Measurements for Systems Not Providing Filtration

Population Served	**Samples/week**
less than 500	1
501 to 3300	2
23,300 to 10,000	3
10,001 to 25,000	4
more than 25,000	5

2. Turbidity. Measurements must be performed on the source water immediately before the first or only point of disinfection every 4 hours by grab sampling or by continuous monitoring.

3. Parameters Measured to Determine Total Inactivation Ratio

a) Temperature. The temperature of the disinfected water must be measured at least once a day at each residual disinfectant concentration sampling point.

b) pH. If the system uses chlorine, the pH of the disinfected water must be measured at least once a day at each chlorine residual disinfectant concentration sampling point.

c) Disinfectant Contact Time. The disinfectant contact time (T) must be determined for each day during peak hourly flow.

d) Residual Disinfectant Concentration. The residual disinfectant concentration (C) of the water before or at the first customer must be measured each day during peak hourly flow.

4. Disinfectant Contact Time[7]

a) Definition. The contact time of mixing basins and storage reservoirs used in calculating CT should be the detention time at which 90 percent of the water passing through the unit is retained within the basin, T_{10}.

b) Tracer Studies. Tracer studies are used to get detention times associated with various flow rates for each particular treatment plant. Detention times also depend on the water level in storage tanks. When tracer studies are performed, water levels should be near normal operating conditions. Two typical methods for conducting tracer studies are the step-dose method and the slug-dose method. If doing a tracer study is prohibitively expensive or impractical, the State may allow the use of "rule-of-thumb" techniques to estimate the detention time.

[7] See *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources*, Appendix C (USEPA Office of Drinking Water, October 1989).

5. Total Inactivation Ratio

a) Definition. The total inactivation ratio is a measure of the degree of inactivation achieved through using a particular treatment process. The 3 log inactivation ratio is defined as

$$\frac{CT_{calc}}{CT_{99.9}}$$

where C = residual disinfectant concentration, and
T = disinfectant contact time.

The 4 log inactivation ratio is defined as

$$\frac{CT_{calc}}{CT_{99.99}}$$

where C = residual

disinfectant concentration, and

T = disinfectant contact time.

b) Determination

(1) General Requirements. The total inactivation ratio for each day that the system is in operation must be determined based on the $CT_{99.9}$ values for *Giardia* and the $CT_{99.99}$ for viruses as shown in the EPA tables.[8] In order to comply, a system not providing filtration must provide 99.9 percent removal of *Giardia* and 99.99 percent removal of viruses solely through disinfection.

(2) CT*calc*. CT_{calc} is determined by multiplying the residual disinfectant concentration value (C) by the contact time (T) from above.

(3) CT*99.9* and CT*99.99*. $CT_{99.9}$ for *Giardia* and $CT_{99.99}$ for viruses are found on tables provided by the EPA. These numbers vary with pH, disinfectant, and temperature.

(4) Method of calculation. A separate total inactivation ratio for both *Giardia* and viruses must be calculated. The following description applies to both, although only *Giardia* will be discussed specifically.

(a) One point of disinfection. For only one point of disinfection there are two possible methods.

i) One inactivation ratio $CT_{calc}/CT_{99.9}$ is determined before or at the first customer during peak hourly flow. If the ratio is greater than or equal to 1, the 99.9 percent removal has been achieved.

ii) Successive $CT_{calc}/CT_{99.9}$ values representing sequential inactivation ratios are determined between the point of disinfectant application and

[8] *Guidance Manual for Compliance.*

a point at or before the first customer during peak hourly flow. Using this alternative, the following method must be used to calculate the total inactivation ratio: first determine the ratio for each sequence; add the ratios together; if the sum is greater than 1, the required inactivation has been achieved.

(b) More than one point of disinfection. For more than one point of disinfection the system must determine the CT value of each disinfection sequence immediately before the next point of disinfectant application during peak hourly flow. The inactivation ratio value of each sequence and the sum of all the ratios must be calculated as in ii above.

6. Residual Disinfectant Entering the Distribution System. The residual disinfectant concentration of the water entering the distribution system must be monitored continuously, and the lowest value must be recorded each day. If the continuous-monitoring equipment fails, grab-sample monitoring every 4 hours is allowed for up to 5 working days for equipment repair. Systems serving less than 3300 people may take grab samples in lieu of providing continuous monitoring on an ongoing basis at the frequencies shown in Table C3. Anytime the residual disinfectant concentration falls below 0.2 mg/l in a system using grab samples in lieu of continuous monitoring, the system must take a grab sample every 4 hours until the residual disinfectant is equal to or greater than 0.2 mg/l.

7. Residual Disinfectant Concentration in the Distribution System. The residual disinfectant concentration in the distribution system must be measured at least at the same points in the distribution system and at the same time as total coliforms are sampled under the Total Coliform Rule. The State may allow a public water system that uses both a surface water source and a groundwater source under the influence of surface water, or a system that uses a surface water source and a groundwater source, to sample at other points if the State determines that such points are more representative of the treated water quality within the distribution system. Heterotrophic plate count (HPC) may be measured in lieu of disinfectant residual.

IV. PUBLIC NOTIFICATION

A. General Requirements. All general public notification requirements apply. Refer to Chapter 4 for a description of those requirements.

B. Mandatory Language. Mandatory language for microbiological contaminants is provided below for use when there is a violation of the treatment technique requirements:

"The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that microbiological contaminants are a health concern at certain levels of exposure. If water is inadequately treated, microbiological contaminants in that water may cause disease. Disease symptoms may include diarrhea, cramps, nausea, and possibly jaundice and any associated headaches, and fatigue. These symptoms, however, are not just associated with disease-causing organisms in drinking water, but also may be caused by a number of factors other than your drinking water. EPA has set enforceable requirements for treating drinking water to reduce the risk of these adverse health effects. Treatment such as filtering and disinfecting the water removes or destroys microbiological contaminants. Drinking water which is treated to meet EPA requirements is associated with little to none of this risk and should be considered safe."

Table C3

Samples Required for Residual Disinfectant Entering Distribution System for Populations Less Than 3300

Population Served	Samples/Day
< 500	1
501 to 1000	2
1001 to 2500	3
2501 to 3300	4

V. VARIANCES AND EXEMPTIONS

A. **Variance.** No variances allowed from filtration requirements or disinfection requirements.

B. **Exemption.** Possible for both filtration requirements and level of disinfection.

VI. ANALYTICAL METHODS In accordance with *Standard Methods*:[9]

A. Fecal Coliform Concentration

Method 908C—Fecal Coliform MPN Procedures
Method 908D—Estimation of Bacterial Density
Method 909C—Fecal Coliform Membrane Filter Procedure

B. Total Coliform Concentration

Method 908A—Standard Total Coliform Multiple-Tube (MPN) Tests
Method 908B—Application of Tests to Routine Examinations
Method 908D—Estimation of Bacterial Density
Method 909A—Standard Total Coliform Membrane Filter Procedure
Method 909B—Delayed-Incubation Total Coliform Procedure
Minimal Medium ONPG-MUG Test (Autoanalysis Coliert System)[10]

C. Heterotrophic Plate Count (HPC)

Method 907A—Pour Plate Method

D. Turbidity

Method 214A—Nephelometric Method - Nephelometric Turbidity Units

[9] *Standard Methods for the Examination of Water and Wastewater*, 1985, American Public Health Association et al., 16th edition.
[10] In accordance with Edberg et al., "National Field Evaluation of a Defined Substrate Method for the Simultaneous Enumeration of Total Coliforms and Escherichia Coli from Drinking Water: Comparison with the Standard Multiple Tube Fermentation Method," *Applied and Environmental Microbiology*, Vol 54 (June 1988), pp 1595-1601 (as amended, under Erratum Vol 54, p 3197, December 1988).

E. Residual Disinfectant Concentration
For free chlorine and combined chlorine:

Method 408C—Amperometric Titration Method
Method 408D—DPD Ferrous Titrimetric Method
Method 408E—DPD Colorimetric Method
Method 408F—Leuco Crystal Violet Method

For ozone:

Indigo Method[11]

For chlorine dioxide:

Method 410B—Amperometric Method
Method 410C—DPD Method

F. Temperature

Method 212—Temperature

G. pH

Method 423—pH Value

VII. TIMETABLE

A. General Dates

1. **3 November 1987**—Proposed Rule

2. **29 June 1989**—final rule

3. **30 December 1990**—State regulations to implement the SWTR must be in place by this date. States must adopt procedures to determine whether a groundwater is under the influence of surface water by this date.

B. Groundwater Systems

1. **29 June 1994**—For community water systems, the State must determine if that system uses groundwater under the direct influence of surface water.

2. **29 June 1990**—For noncommunity water systems the State must determine if that system uses groundwater under the direct influence of surface water.

[11] In accordance with H. Bader and J. Hoigne, "Determination of Ozone in Water by the Indigo Method: A Submitted Standard Method," *Ozone Science and Engineering*, Vol 4 (Pergamon Press Ltd., 1982), pp 169-176.

C. Surface Water Systems Currently Unfiltered

1. 30 December 1990—Monitoring requirements for unfiltered systems must be met unless the primacy agent has determined that filtration is necessary. In that case, interim regulations will apply until 29 June 1993.

2. 30 December 1991

a) The requirements to avoid filtration go into effect. Beginning at this time, if a system fails to meet any of the criteria to avoid filtration, it will be required to install filtration within 18 months of the failure.

b) States must decide which systems will be required to filter by this time. If the State determines before this date that an unfiltered system must filter, the system must comply with the interim regulations until 29 June 1993.

3. 29 June 1993

a) If filtration is required, it must be installed by this date or 18 months after the determination is made, whichever is later.

b) If the primacy agent has not complied with the schedule for determining if filtration is necessary, the water system must comply with "self implementing" criteria by this date.

c) All systems with filtration in place must comply with filtration criteria, disinfection criteria, and monitoring and reporting requirements.

D. Surface Water Systems Currently Filtered

29 June 1993—All systems with filtration in place must meet filtration criteria, disinfection criteria, and monitoring and reporting requirements. The existing interim standards will continue until this date.

VIII. CRITERIA FOR DETERMINING IF FILTRATION IS REQUIRED

A. Source Water Quality Criteria

1. Coliform Limits

a) In water prior to disinfection, fecal coliform concentration is less than 20/100ml or total coliform concentration is equal to or less than 100/100ml in at least 90 percent of the samples.

b) Minimum sampling frequencies are as shown in Table C4.

2. **Turbidity Limits**. The turbidity of the water prior to disinfection must be less than 5 NTU on an ongoing basis, based on grab samples taken every 4 hours. A system may occasionally exceed the 5 NTU limit and still avoid filtration as long as:

Table C4

Minimum Coliform Density Sampling Frequency for Systems Not Providing Filtration

Population Served	Samples/week
< 500	1
501 to 3300	2
3301 to 10,000	3
10,001 to 25,000	4
25,001 or more	5

a) The State determines that each event occurred because of unusual or unpredictable circumstances and,

b) As a result of this event, there have not been more than two such events in the past 12 months the system served the public,or more than five such events in the past 120 months.*

B. Disinfection Criteria

1. Level of Disinfection

a) Disinfection operation conditions must achieve 99.9 percent removal of *Giardia* and 99.99 percent removal of viruses as demonstrated by achieving appropriate CT values.**

b) The CT value must be calculated each day the system serves water to the public.

2. Disinfection at the Point of Entry to Distribution System

a) Disinfectant residual at the point of entry into the distribution system cannot be less than 0.2 mg/l for more than 4 hours.

b) Systems serving more than 3300 people must monitor disinfectant residual continuously. Grab sampling may be substituted for up to 5 working days following equipment failure.

c) Systems serving less than 3300 people may use grab sampling for disinfectant residual at the frequencies shown in Table C5.

3. **Disinfectant Residual in the Distribution System Requirement.** The disinfectant residual in the distribution system cannot be undetectable in more than 5 percent of the samples in a month.

* An "event" is defined as a series of consecutive days in which at least one turbidity measurement each day exceeds 5 NTU.

** The system is in violation of the treatment technique if it fails to achieve the required inactivation ratio any 2 or more days in a month. If two violations occur during 1 year, the system must install filtration unless the State determines that the cause of at least 1 of these violations was due to unusual or unpredictable circumstances. Three violations in 1 year trigger the filtration requirement regardless of the cause of the violations.

Table C5

Grab Sampling Frequency for Systems Serving Populations Less Than 3300

Population Served	Samples/Day
< 500	1
501 to 1000	2
1001 to 2500	3
2501 to 3300	4

4. **Redundant Disinfection or Automatic Shutoff.** System must have either a redundant disinfection system, including an auxiliary power supply, or an automatic shutoff when the disinfectant residual in the system falls below 0.2 mg/l.

C. Site-Specific Criteria

1. **Watershed Control Program.** A watershed control program must include as a minimum the following four components:

a) A description of the watershed including its hydrology and land ownership

b) Identification, monitoring, and control of watershed characteristics and activities in the watershed that may have an adverse effect on the source water quality

c) A program to gain ownership or control of the land within the watershed through written agreements with landowners, for the purpose of controlling activities that will adversely affect the microbiological quality of the water

d) An annual report that identifies special concerns in the watershed and how they are being handled, identifies activities in the watershed, and projects adverse activities expected to occur in the future and how the utility expects to address them.

2. **On-Site Inspections.** An annual on-site inspection is required to evaluate watershed control program and disinfection facilities. This inspection must be performed by a party approved by the primacy agent.

3. **No Waterborne Disease Outbreaks.** A surface water system that does not provide filtration must not have been identified as the source of waterborne disease. If it has been so identified, the system must have been modified to prevent another outbreak to the satisfaction of the primacy agent.

4. **Compliance with the Total Coliform MCL.** A system must comply with the MCL for total coliform for at least 11 of 12 of the previous months.

5. **Compliance with the Total Trihalomethane Regulation.** Applies to systems serving more than 10,000 people. A system must comply with the total trihalomethane MCL.

APPENDIX D: Total Coliform Rule

I. GENERAL REQUIREMENTS

A. Applicability. The requirements of the Total Coliform Rule apply to all public water systems.

B. Maximum Contaminant Level Goal. MCLG for Total Coliforms, including fecal coliforms and *Escherichia coli* (*E.coli*), is 0.

C. Maximum Contaminant Levels and Compliance Requirements. For systems analyzing at least 40 samples per month, no more than 5.0 percent of the monthly samples may be total-coliform-positive. For systems analyzing less than 40 samples per month, no more than one sample per month may be total-coliform-positive. This MCL is based on the simple presence or absence of coliforms, as opposed to coliform density.

If a routine sample tests positive for total coliforms, subsequently tests positive for fecal coliforms or *E. coli*,* and the repeat sample tests positive for total coliforms, fecal coliforms, or *E. coli*, then the system is in violation of the MCL for total coliforms. This is an acute violation for purposes of public notification.

A public water system must determine compliance with the MCL for total coliforms every month it is required to monitor for total coliforms.

D. Sanitary Survey. All systems collecting fewer than five samples per month must have a periodic sanitary survey.

E. Sample Siting Plan. Every system must sample according to a written sample siting plan that is approved by the State.

II. BEST AVAILABLE TECHNOLOGY

A. Well Protection. Protection of wells from contamination by coliforms by appropriate placement and construction.

B. Disinfectant Residual. Maintenance of a disinfectant residual throughout the distribution system.

C. Maintenance. Proper maintenance of the distribution system, including appropriate pipe replacement and repair procedures, main-flushing programs, proper operation and maintenance of storage tanks and reservoirs, and continual maintenance of positive water pressure in all parts of the distribution system.

D. Filtration/Disinfection. Filtration and/or disinfection of surface water as defined in 40 CFR Part 141, Subpart H. Disinfection of groundwater using strong oxidants such as chlorine, chlorine dioxide, or ozone.

E. Wellhead Protection Program. The development and implementation of an EPA-approved state wellhead protection program under section 1428 of the Safe Drinking Water Act.

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* If the system assumes that the total-coliform-positive sample is fecal coliform positive, the State may allow the system to forgo fecal coliform or *E. coli* testing.

III. MONITORING REQUIREMENTS

A. General Requirements. Results of all routine and repeat samples not invalidated by the State must be included in determining compliance with the MCL for total coliforms. Figure D1 shows the coliform monitoring requirements.

B. Routine Monitoring

1. Sample Siting Plan. Public water systems must collect total coliform samples according to a written sample siting plan prepared by the installation and approved by the State. These samples must be taken at sites that are representative of water throughout the distribution system.

2. Monthly Monitoring Requirements. Monthly monitoring requirements for community water systems are based on population served as shown in Table D1. This table represents a reduction in the number of monitoring categories from the number previously used to determine monthly monitoring requirements. The requirements for noncommunity water systems are shown in Table D2. The public water system must collect samples at regular time intervals throughout the month (except ground water under the direct influence of surface water and serves 4900 persons or fewer may collect all required samples on a single day if they are taken from different sites).

The public water system must collect samples at regular time intervals throughout the month (except ground water and serves 4900 persons or fewer may collect all required samples on a single day if they are taken from different sites).

3. Reduced Monitoring Frequency. If a community water system serving 25 to 1000 persons has no history of total coliform contamination in its current configuration, and has had a sanitary survey in the past 5 years that shows the system is supplied solely by a protected groundwater source and is free from sanitary defects, the State may reduce the monitoring frequency to no less than once per quarter. The public water system must collect samples at regular time intervals throughout the month. Exception: a system that uses groundwater and serves 4900 persons or fewer may collect all required samples on a single day if the samples are taken from different sites.

4. Unfiltered Sources. A public water system that uses surface water or groundwater under the influence of surface water and does not practice filtration must collect at least one sample near the first service connection each day the turbidity level of the source water is greater than 1 NTU. This sample must be analyzed for total coliforms. Sample results from this coliform monitoring must be included in determining compliance with the MCL for total coliforms.

5. Special-Purpose Samples. Special-purpose samples, such as those taken to determine whether disinfection practices are sufficient following pipe placement, etc., shall not be used to determine compliance with the MCL for total coliforms.

C. Repeat Monitoring

1. Allowable Time Period. If a routine sample is total-coliform-positive, the system must collect a set of repeat samples within 24 hours of being notified of the result. The State may extend this 24-hour limit on a case-by-case basis if the system has a logistical problem beyond its control in collecting repeat samples. For each extension, the State must specify its time limit.

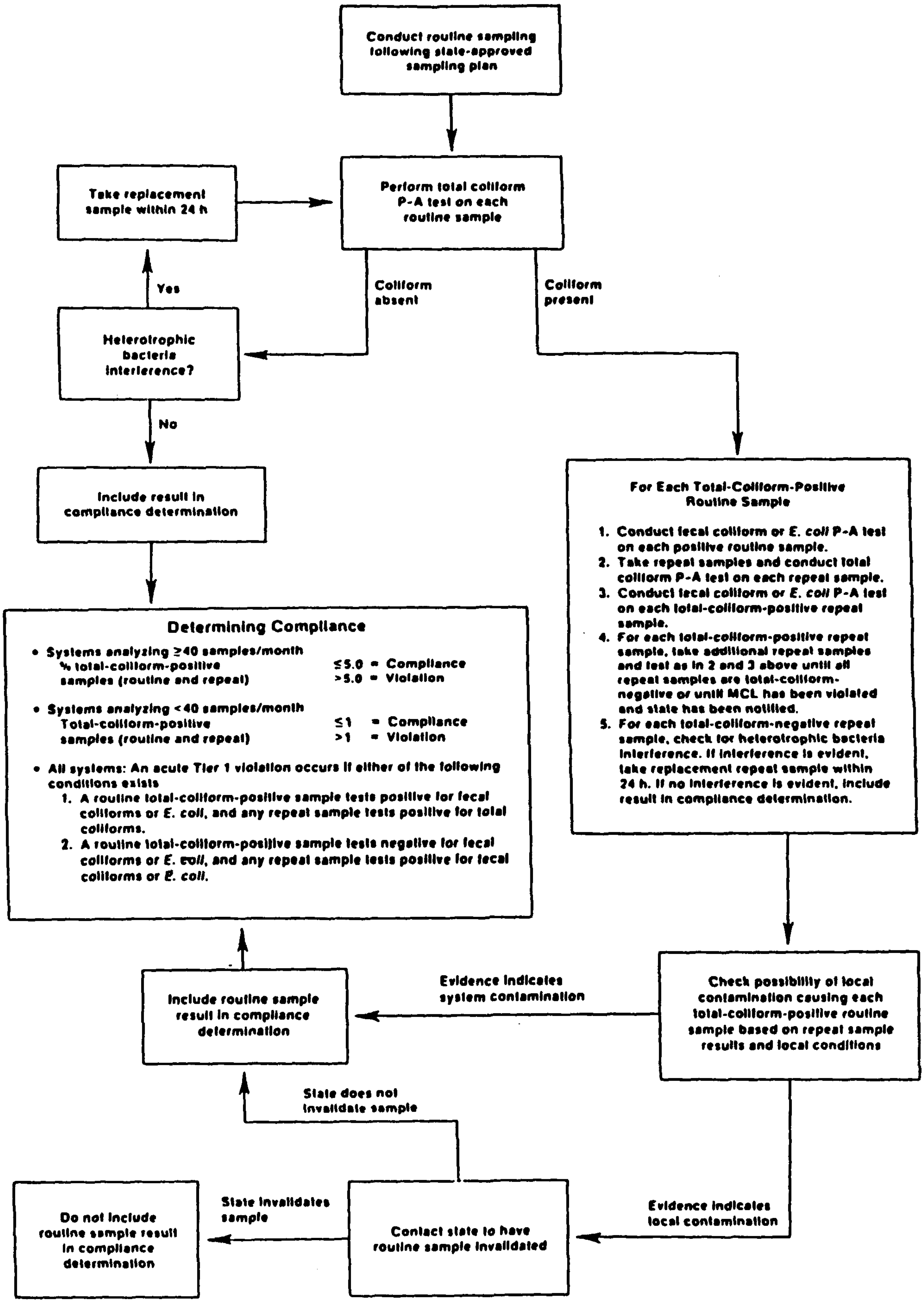

Figure D1. Coliform Monitoring Requirements. (Reprinted from *Opflow*, Vol 16, No. 22 [December 1990] by permission. Copyright 1990 American Water Works Association.)

Table D1

Total Coliform Sampling Requirements for Community Water Systems According to Population Served

Population	Minimum Number of Routine Samples per Month
25-1000	1
1001-2500	2
2501-3300	3
3301-4100	4
4101-4900	5
4901-5800	6
5801-6700	7
6701-7600	8
7601-8500	9
8501-12,900	10
12,901-17,200	15
17,201-21,500	20
21,501-25,000	25
25,001-33,000	30
33,001-41,000	40
41,001-50,000	50
50,001-59,000	60
59,001-70,000	70
70,001-83,000	80
83,001-96,000	90
96,001-130,000	100
130,001-220,000	120
220,001-320,000	150
320,001-450,000	180
450,001-600,000	210
600,001-780,000	240
780,001-970,000	270
970,001-1,230,000	300
1,230,001-1,520,000	330
1,520,001-1,850,000	360
1,850,001-2,270,000	390
2,270,001-3,020,000	420
3,020,001-3,960,000	450
3,960,00 or more	480

All repeat samples must be collected on the same day. The State may allow a system with a single service connection to collect the samples over a 4 day period in one or more sample containers of any size, as long as the total volume collected is at least 400 ml (300 ml for systems that collect more than one routine sample per month). A system must collect a set of repeat samles for each total coliform-positive routine sample.

If a system has only one service connection, the State has the discretion to allow the system to either collect the required set of repeat samples at the same tap over a four day period, or to collect a larger volume repeat sample (i.e., 400 ml).

Table D2

Total Coliform Monitoring Frequency for Noncommunity Water Systems

Type of System	Sampling Frequency (Minimum Frequency If State Approved)
Noncommunity water system using only groundwater serving less than 1000 people.	Quarterly (Yearly)
Noncommunity water system using only groundwater serving more than 1000 people.	Same as like-sized community system.
Noncommunity water system using surface water.	Same as like-sized community system.
Noncommunity water system using groundwater under the influence of surface water.	Same as like-sized community system.

2. Number of Repeat Samples Required. Systems collecting more than one routine sample per month must collect no fewer than three repeat samples for each total-coliform-positive sample found. Systems collecting only one sample per month must collect no fewer than four repeat samples for each total-coliform-positive result. After a system collects a routine sample and before the result is known, if the system collects another sample within five service connections of the initial sample, that sample may be counted as a repeat sample instead of a routine sample (but not both) if the initial sample is total-coliform-positive. If a system has only one service connection, the State has the discretion to allow the system to either collect the required set of repeat samples at the same tap over a four day period, or to collect a larger volume repeat sample (i.e., 400 ml).

3. Location of Repeat Samples. One repeat sample must be at the sampling tap where the original positive sample was taken. One sample must be taken within five service connections upstream and within five service connections downstream. If the sample was taken at the end of the distribution system, or one away from the end of the distribution system, the State my waive the upstream or downstream requirement.

4. Additional Routine and Repeat Samples. If one of the repeat samples is total-coliform-positive, another set of samples must be collected. The repeat samples must be collected within 24 hours of being notified of the positive result, unless the State extends the limit. This process continues until either the complete set of repeat samples is total coliform-negative, or the MCL for total coliforms is exceeded and the State notified. If a system routinely collecting fewer than five samples per month has one or more total-coliform-positive result, it must collect at least five routine samples during the next month. If the State performs a site visit before the end of the next month, this requirement may be waived.

D. Fecal Coliforms/*E. coli* Testing

1. General Requirements. If any routine or repeat sample is total-coliform-positive, the system must analyze that total-coliform-positive culture medium to determine if fecal coliforms are present. The system may test for *E. coli* in lieu of fecal coliforms. If fecal coliforms are present, the system must notify the State before the end of the day. If the State office is closed, the deadline is the end of the next business day.

2. Forgoing Fecal Coliform or *Escherichia coli* Testing. The State may allow a system to forgo fecal coliform/*E. coli* testing if a total-coliform-positive result is treated as fecal-coliform-positive in regards to MCL compliance, public notification, and State notification.

E. Invalidation of Samples

1. General Requirements. An invalidated sample does not count toward minimum monitoring requirements.

2. State Invalidation. The State may invalidate a sample only if one of the following conditions is met:

a) The laboratory determines that improper sample analysis caused the positive result

b) The State determines on the basis of repeat samples that the positive sample resulted from a domestic problem or a problem not involving the distribution system.*

c) The State has substantial grounds to believe that a total-coliform-positive result is due to a circumstance or condition that does not reflect water quality in the distribution system. In such a case the system must still collect all repeat samples required. The decision and the rationale for the decision must be documented in writing and approved and signed by the supervisor of the State official who recommended this decision. This document must be made available to the EPA and the public.

3. Laboratory Invalidation. A laboratory *must* invalidate a total coliform sample (unless total coliforms are detected) if the sample produces a turbid culture in the absence of gas production when using an analytical method where gas production is examined. A sample must be invalidated if it produces a turbid culture in the absence of an acid reaction in the Presence-Absence Coliform Test. Also, if the sample exhibits confluent growth or produces colonies too numerous to count with an analytical technique using a membrane filter, it must be invalidated. If a sample is invalidated, the system must collect another sample from the same location within 24 hours of being notified of the interference problem.

IV. SANITARY SURVEYS

Public water systems that do not collect five or more routine samples per month must undergo an initial sanitary survey and repeat surveys by the dates shown in Table D3.

* The State cannot invalidate a sample on the basis of repeat sample results unless all repeat samples collected at the same tap as the original total-coliform-positive sample are also total-coliform-positive and all repeat samples collected within five service connections of the original tap are total-coliform-negative.

Table D3

Sanitary Survey Frequency for Public Water Systems Collecting Fewer Than Five Samples Per Month

System Type	Initial Survey Completed By	Frequency of Subsequent Surveys
Community	29 June 1994	Every 5 years
Noncommunity	29 June 1999	Every 5 years
Noncommunity (using protected and disinfected groundwater)	29 June 1999	Every 10 years

Sanitary surveys must be performed by the State or an agent approved by the State. The system is responsible for ensuring that the survey takes place.

V. PUBLIC NOTIFICATION

A. General Requirements. All general public notification requirements apply. Refer to Chapter 4 for a description of those requirements.

B. Mandatory Language

1. Violation of the total coliform MCL. Violation of the total coliform MCL, but not the fecal coliform repeat-sample MCL, requires use of the following language:

"The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that the presence of total coliforms is a possible health concern. Total coliforms are common in the environment and are generally not harmful themselves. The presence of these bacteria in drinking water, however, generally is a result of a problem with water treatment or the pipes which distribute the water, and indicates that the water may be contaminated with organisms that can cause disease. Disease symptoms may include diarrhea, cramps, nausea, and possibly jaundice, and any associated headaches and fatigue. These symptoms, however, are not just associated with disease-causing organisms in drinking water, but also may be caused by a number of factors other than your drinking water. EPA has set an enforceable drinking water standard for total coliforms to reduce the risk of these adverse health effects. Under this standard, no more than 5.0 percent of the samples collected during a month can contain these bacteria, except that systems collecting fewer than 40 samples per month that have one total coliform-positive sample per month are not violating the standard. Drinking water which meets this standard is usually not associated with a health risk from disease-causing bacteria and should be considered safe."

2. Violation of the fecal coliform MCL. Violation of the fecal coliform or *E. coli* MCL, or both the fecal coliform (or *E. coli*) and total coliform MCL requires use of the following language:

"The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that the presence of fecal coliforms or *E. coli* is a serious health concern. Fecal coliforms and *E. coli* are generally not harmful themselves, but their presence in drinking water is serious because they usually are associated with sewage or animal wastes. The presence of these bacteria in drinking water is generally a result of a problem with water treatment or the pipes which distribute the water and indicates that the water may be contaminated with organisms that can cause disease. Disease symptoms may include diarrhea, cramps, nausea, and possibly jaundice, and associated headaches and fatigue. These symptoms, however, are not just associated with disease-causing organisms in drinking water, but also may be caused by a number of factors other than your drinking water. EPA has set an enforceable drinking water standard for fecal coliform and *E. coli* to reduce the risk of these adverse health effects. Under this standard all drinking water samples must be free of these bacteria. Drinking water which meets this standard is associated with little or none of this risk and should be considered safe. State and local health authorities recommend that consumers take the following precautions: [To be inserted by the public water system, according to instructions from State or local authorities]."

VI. VARIANCES AND EXEMPTIONS

There are no exemptions allowed for the Total Coliform Rule. As of December 1990, a system could obtain a variance if it meets a state's approved criteria. USEPA plans on developing national criteria for obtaining a variance. Some nonfecal-coliform species of microorganisms (such as *Klebsiella pneumoniae*) give positive results in fecal coliform analysis and therefore trigger public notification. These positive analytical results do not indicate fecal contamination. The variance is intended for systems encountering nonfecal biofilm problems in their distribution systems.

VII. ANALYTICAL METHODS

A. General Requirements

1. The standard sample volume required for total coliform analysis is 100 ml regardless of analytical method used.

2. Only presence or absence of coliform needs to be determined.

B. Total Coliform Analysis. The following are the required EPA-approved methods, in accordance with *Standard Methods* (16th ed.):[12]

1. **Method 908A**—Standard Total Coliform Multiple-Tube (MPN) Test (10 fermentation tubes must be used, or five tubes with 20 ml samples, or a single culture bottle containing the culture medium for the MTF method).

2. **Method 908E**—Presence-Absence (P-A) Coliform Test.

3. **Method 909A**—Standard Total Coliform Membrane Filter Procedure.

4. **Method 909B**—Delayed-Incubation Total Coliform Procedure.

[12] *Standard Methods*, 16th ed.

5. Minimal Medium ONPG-MUG (MMO-MUG) Test (Autoanalysis Coliert System)[13] (This method is approved for total coliform analysis, but as of June 1991 it had not been approved for *E. Coli*, and EPA had not approved the transfer of a total-coliform positive sample from MMO-MUG to other media. Thus, this test is not appropriate for determining compliance with the Total Coliform Rule.)

C. **Fecal Coliform Analysis.** In accordance with *Standard Methods* (16th ed.):

1. For the MTF technique or the Presence-Absence Coliform Test—Shake the lactose-positive presumptive tube or P-A bottle vigorously and transfer the growth with a sterile 3mm loop or sterile applicator stick into brilliant green lactose broth and EC medium to determine the presence of total and fecal coliforms, respectively.

2. For the Membrane Filter Method—Remove the membrane containing the total coliform colonies from the substrate with a sterile forceps and carefully curl and insert the membrane into a tube of EC medium. (The laboratory may first remove a small portion of selected colonies for verification.) Gently shake the innoculated EC tubes to ensure adequate mixing and incubate in a water bath at 44.5 ± 0.2°C for 24 ± 2 hours. Gas production of any amount in the inner fermentation tube of the EC medium indicates a positive fecal coliform test.

3. Method 908C—Fecal Coliform MPN Procedure (above) describes how the EC medium should be prepared.

D. ***E. coli* Analysis**

1. EC Medium Plus MUG—In this test EC medium, as defined in the 16th edition of *Standard Methods* (p 879) is supplemented with 50 µg/l (final concentration) of MUG. After the laboratory incubates the broth at 44.5 °C for 24 hours, it observes if fluorescence is visible when exposed to ultraviolet light.[14]

2. Nutrient Agar Plus MUG—This test would be used to determine if a total-coliform-positive sample, as determined by the Membrane Filter Technique or any other method that employs a membrane filter, contains *E. coli.* The laboratory would transfer a membrane filter containing a total coliform colony to nutrient agar supplemented with 100 µg/l (final concentration) of MUG. After incubating the nutrient agar plate at 35 °C for 4 hours, the laboratory would observe the colony in a darkened room for fluorescence.[15]

3. Minimal Medium ONPG-MUG Test—This method has been proposed for use, but as of June 1991 had not been approved by USEPA. If a laboratory uses a MMO-MUG test for total coliform detection, and the culture becomes yellow after incubation (i.e., total-coliform-positive), the laboratory would detect the presence of *E. coli* by placing the culture close to an ultraviolet light source in a darkened environment to detect fluorescence.

[13] In accordance with Edberg et al.

[14] S. L. Chandler Rippey and W. Watkins, "Fluorometric method for enumeration of Escherichia coli in molluscan shellfish," *Journal of Food Protection*, Vol 50 (1987), pp 685-690.

[15] A. Mates and M. Shaffer, "Membrane filtration differentiation of E. coli from coliforms in the examination of water," *Journal of Applied Bacteriology*, Vol 67 (1989), pp 343-346.

VIII. TIMETABLE

A. **Proposed Rule**—3 November 1987

B. **Final Rule**—29 June 1989

C. **Compliance Dates**

31 December 1990—All requirements go into effect.

29 June 1994—Initial sanitary survey must be completed for community water systems.

29 June 1999—Initial sanitary survey must be completed for noncommunity water systems.

APPENDIX E: Synthetic Organic Chemicals and Inorganic Chemicals Rule (Phase II)

I. GENERAL REQUIREMENTS

A. Maximum Contaminant Level Goals and Maximum Contaminant Levels. Table E1 shows the MCLs and MCLGs for this rule. Five contaminants for which MCLs were proposed were not included in the final rule. The MCLs for aldicarb, aldicarb sulfone, aldicarb sulfoxide, pentachlorophenol, and barium were reproposed at the time the Phase II rule was finalized.

B. Reproposed Maximum Contaminants Levels. Table E2 lists the MCLs and MCLGs reproposed by USEPA at the time of the final rule.

C. Secondary Maximum Contaminant Levels.

Aluminum: 0.05 to 0.2 mg/l
Silver: 0.1 mg/l

D. Treatment Technique Requirements. As shown in Table E1, treatment techniques are prescribed for acrylamide and epichlorohydrin instead of MCLs. Each public water system must certify annually in writing to the State (using third-party or manufacturers certification) that when acrylamide and epichlorohydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the following levels:

Acrylamide—0.05 percent dosed at 1 ppm (or equivalent)
Epichlorohydrin—0.01 percent dosed at 20 ppm (or equivalent).

The water system does not need to test for monomers because the manufacturer's certification is sufficient.

II. BEST AVAILABLE TECHNOLOGY

The SDWA-designated BAT for all SOCs is GAC. All other technologies designated as BAT must be at least as effective as GAC. The BAT for each specific contaminant is shown on Table 3 in Chapter 2.

III. MONITORING REQUIREMENTS

A. General Requirements. The monitoring requirements for these contaminants are similar to those for other organic and inorganic chemicals. The monitoring for the VOCs that are regulated under this rule follows the standardized monitoring framework for organic chemicals. In general, USEPA has set up a base monitoring level from which a State may increase or decrease the monitoring frequency. Monitoring is increased whenever a contaminant level exceeds a certain trigger value. Specifically, the trigger values are 0.5 mg/l for nitrite, 5 mg/l for nitrate, and 5 mg/l for nitrite and nitrate combined; equal to the MCL values for asbestos and the inorganics; and equal to the analytical detection limits for VOCs, PCBs, and pesticides. The detection limit for VOCs is 0.0005 mg/l. When a system exceeds a trigger value, it automatically goes to quarterly monitoring to establish a baseline for analytical results.

Table E1

MCLs and MCLGs for the SOCs and IOCs Rule (Phase II)

Contaminant **Inorganic Chemicals**	**MCLG** **(mg/l)**	**MCL** **(mg/l)**
Asbestos	7 million fibers/liter (longer than 10μm)	SAME AS MCLG
Cadmium	0.005 mg/l	SAME
Chromium	0.1 mg/l	SAME
Mercury	0.002 mg/l	SAME
Nitrate	10 mg/l (as N)	SAME
Nitrite	1 mg/l (as N)	SAME
Total Nitrite and Nitrate	10 mg/l (as N)	SAME
Selenium	0.05 mg/l	SAME
Volatile Organic Chemicals		
o - Dichlorobenzene	0.6	SAME
cis-1,2-Dichloroethylene	0.07	SAME
trans-1,2-Dichloroethylene	0.1	SAME
1,2-Dichloropropane	0	0.005
Ethylbenzene	0.7	SAME
Monochlorobenzene	0.1	SAME
Styrene	0.1	SAME
Tetrachloroethylene	0	0.005
Toluene	1	SAME
Xylenes(total)	10	SAME
Pesticides and PCBs		
Alachlor	0	0.002
Atrazine	0.003	SAME
Carbofuran	0.04	SAME
Chlordane	0	0.002
1,2-Dibromo-3-chloropropane	0	0.0002
2,4-D	0.07	SAME
Ethylene dibromide	0	0.00005
Heptachlor	0	0.0004
Heptachlor epoxide	0	0.0002
Lindane	0.0002	SAME
Methoxychlor	0.04	SAME
Polychlorinated biphenyls (PCBs) (as decachlorobiphenyl)	0	0.0005
Toxaphene	0	0.003
2,4,5-TP (Silvex)	0.05	SAME
Other Organics		
Acrylamide	0	Treatment technique
Epichlorohydrin	0	

Table E2

Reproposed MCLs and MCLGs for Five Chemicals

Contaminant	Originally Proposed MCL (mg/l)	Currently Proposed MCL (mg/l)	Currently Proposed MCLG (mg/l)
Aldicarb	0.01	0.003	0.001
Aldicarb Sulfoxide	0.01	0.003	0.001
Aldicarb Sulfone	0.04	0.003	0.002
Pentachlorophenol	0.2	0.001	zero
Barium	5	2	2

Source: FR 56:20:3600, *Monitoring for Synthetic Organic Chemicals; MCLGs and MCLs for Aldicarb, Aldicarb Sulfone, Aldicarb Sulfoxide, Pentachlorophenol, and Barium, Proposed Rule (30 January 1991).*

B. Inorganics

1. Groundwater Systems. As a base monitoring level, groundwater systems must take one sample every 3 years, or once during each compliance period. After three samples (9 years of sampling), the sample frequency may be reduced to one sample every 9 years if the level has always been less than the MCL. Sampling must begin in the compliance period beginning 1 January 1993. Any system that exceeds the MCL must monitor quarterly beginning in the quarter following the violation.

2. Surface Water Systems. As a base monitoring level, surface water systems must take one sample every year. After three samples (3 years of sampling) the sample frequency may be reduced to one sample every 9 years if the level has always been less than the MCL. Sampling must begin in the compliance period beginning 1 January 1993. Any system that exceeds the MCL must monitor quarterly beginning in the next quarter after the violation occurred.

C. Asbestos. As a base monitoring level, each community system and noncommunity system nontransient system is required to monitor for asbestos during the first 3-year compliance period of each compliance cycle, i.e., once every 9 years, starting January 1993. Any system that exceeds the MCL must monitor quarterly beginning in the quarter following the violation.

D. Nitrate. All public water systems must monitor for nitrate; waivers for this requirement are not available.

1. Community and Nontransient Noncommunity Groundwater. All CWS and NTNCWS served by groundwater must monitor annually beginning January 1993. If any sample is greater than 50 percent of the MCL, a groundwater system must monitor quarterly for at least 1 year following that sample. The State may reduce the frequency to annually after 4 consecutive samples are reliably and consistently below the MCL.

2. Community and Noncommunity Nontransient Surface Water Systems. All CWS and NCNTWS served by surface water must monitor quarterly beginning January 1993. If all

samples from four consecutive quarters are below 50 percent of the MCL, the State may reduce the frequency to annually. If any subsequent sample is greater than 50 percent of the MCL, the system must return to quarterly monitoring.

3. Noncommunity Transient Systems. All NCTWS must monitor annually beginning January 1993.

E. Nitrite. All public water systems must monitor for nitrite; waivers for this requirement are not available. Each PWS must take one sample at each sampling point during the compliance period beginning 1 January 1993 and ending 31 December 1995. If any sample is greater than 50 percent of the MCL, repeat monitoring frequency will be specified by the State. For any CWS or NCNTWS, the repeat monitoring frequency shall be quarterly for at least 1 year following any sample greater than 50 percent of the MCL.

F. VOCs. Figure E1 shows the monitoring requirements for affected VOCs under the standardized monitoring framework.

1. Community and Noncommunity Nontransient Groundwater Systems—Base Level Monitoring. Groundwater systems must take a minimum of one sample at each entry point to the distribution system that is representative of each well after treatment. Each CWS and NTNCWS must take four consecutive quarterly samples during each compliance period, beginning in the compliance period starting January 1993, i.e., 1 year of quarterly samples every 3 years.

2. Community and Noncommunity Nontransient Surface Water Systems—Base Level Monitoring. Surface water systems must take a minimum of one sample at points in the distribution system that are representative of each source. Each CWS and NCNTWS must take four consecutive quarterly samples during each compliance period, beginning in the compliance period starting January 1993, i.e., 1 year of quarterly samples every 3 years.

3. Reduced Monitoring. Groundwater systems that do not detect any VOCs in the initial round of monitoring are required to take one sample annually. After a minimum of 3 years' annual sampling with nondetect results, the State may reduce sampling to once every compliance period. For surface water systems that do not detect any VOCs, the State may reduce monitoring frequency to annually for vulnerable systems, and to the State's discretion for nonvulnerable systems.

G. Synthetic Organic Chemicals.

1. Community and Noncommunity Nontransient Groundwater Systems—Base Level Monitoring. Groundwater systems shall take a minimum of one sample at every entry point into the distribution system that is representative of each well after treatment. As a base level, each CWS and NCNTWS must take four consecutive quarterly samples during each compliance period beginning with the compliance period that starts January 1993.

2. Community and Noncommunity Nontransient Surface Water Systems—Base Level Monitoring. Surface water systems must take a minimum of one sample at points in the distribution system that are representative of each source, or at each entry point to the distribution system. As a base level, each CWS and NCNTWS must take 4 consecutive quarterly samples during eqach compliance period beginning with the compliance period that starts January 1993.

3. Reduced Monitoring. Systems serving more than 3300 persons that do not detect a contaminant in the initial compliance period may reduce the sampling frequency to a minimum

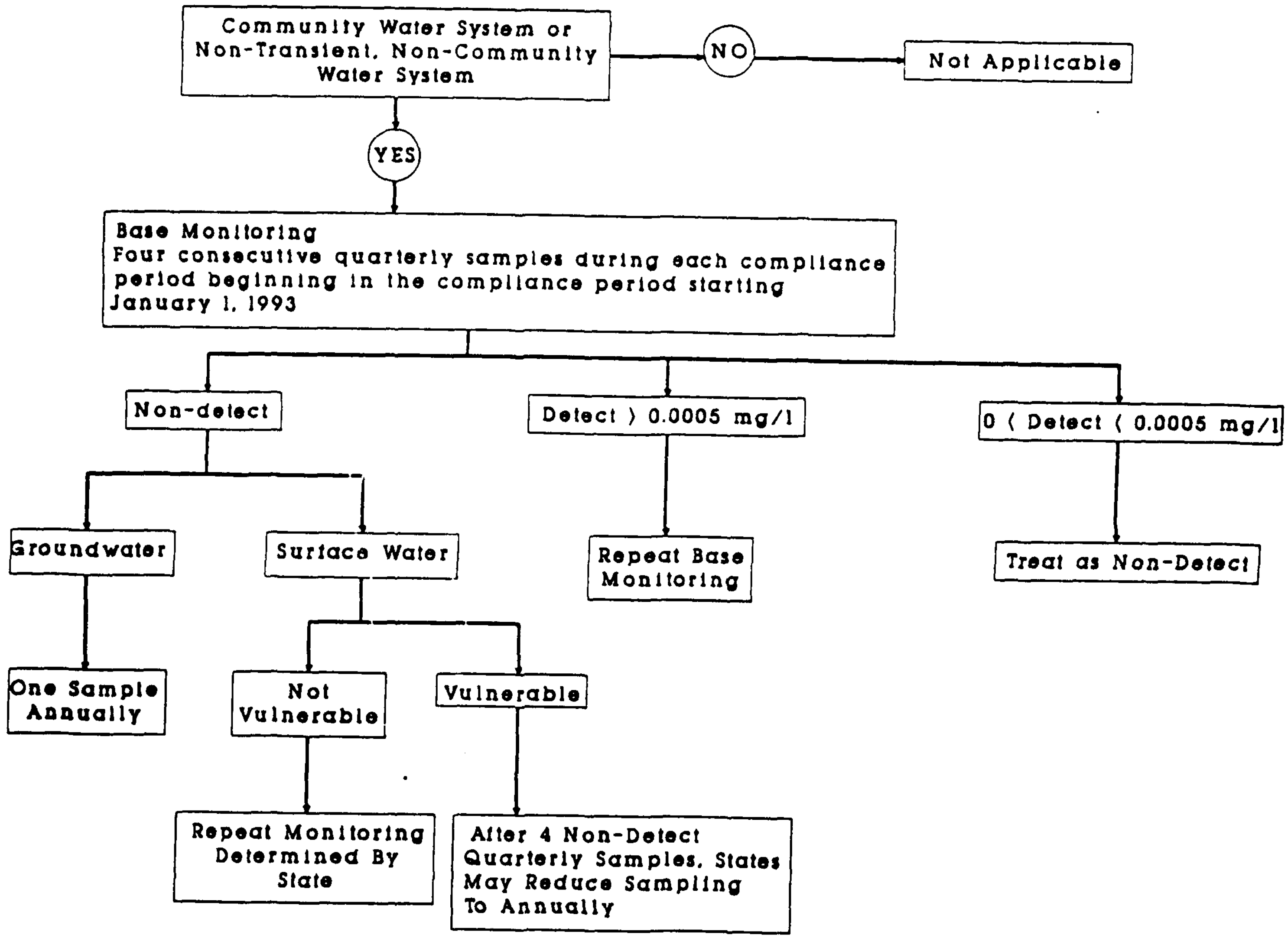

Figure E1. VOC monitoring requirements under SOCs and IOCs (II).

of two quarterly samples in 1 year during each repeat compliance period. Systems serving less than or equal to 3300 persons that do not detect a contaminant in the initial compliance period may reduce the monitoring frequency to a minimum of one sample during each repeat compliance period.

4. Increased Monitoring. If an organic contaminant is detected in any sample, then each system must monitor quarterly at each sampling point where there was a detection.

H. Monitoring for Unregulated Contaminants. Systems must monitor for the contaminants shown in Table E3. Each CWS and NCNTWS must take four consecutive quarterly samples at sampling points used for regulated contaminants and report the results to the State. This monitoring must be completed by 31 December 1995. Instead of taking samples, systems with less than 150 connections may send a letter to the State declaring that the system is available for sampling. This letter must be sent to the State by 1 January 1994.

IV. PUBLIC NOTIFICATION

A. General Requirements. All general public notification requirements apply. Mandatory language required for public notice is given below.

B. Mandatory Language

1. Asbestos. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that asbestos fibers greater than 10 micrometers in length are a health concern at certain levels of exposure. Asbestos is a naturally occurring mineral. Most asbestos fibers in drinking water are less than 10 micrometers in length and occur in drinking water from natural sources and from corroded asbestos-cement pipes in the distribution system. The major uses of asbestos were in the production of cements, floor tiles, paper products, paint, and caulking: in transportation-related applications; and in the production of textiles and plastics. Asbestos was once a popular insulating and fire retardant material. Inhalation studies have shown that various forms of asbestos have produced lung tumors in laboratory animals. The available information on the risk of developing gastrointestinal tract cancer associated with the ingestion of asbestos from drinking water is limited. Ingestion of intermediate-range chrysotile asbestos fibers greater than 10 micrometers in length is associated with causing benign tumors in male rats. Chemicals which cause cancer in laboratory animals also may cause cancer in humans who are exposed over long periods of time. EPA has set the drinking water standard for asbestos at 7 million long fibers per liter to reduce the potential risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to asbestos."

2. Barium (proposed). "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that barium is a health concern at certain levels of exposure. This inorganic chemical occurs naturally in some aquifers that serve as sources of groundwater. It is also used in oil and gas drilling muds, automotive paints, bricks, tiles, and jet fuels. It generally gets into drinking water after dissolving from naturally occurring minerals in the ground. This chemical may damage the heart and cardiovascular system, and is associated with high blood pressure in laboratory animals such as rats exposed to high levels during their lifetimes. In humans, EPA believes that effects from barium on blood pressure should not occur below 10 ppm in drinking water. EPA has set the drinking water standard for barium at 2 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to barium."

Table E3

Unregulated Contaminants That Must Be Monitored

Organics	Methomyl
Aldrin	Metolachlor
Benzo(a)pyrene	Metribuzin
Butachlor	Oxamyl (Vydate)
Carbaryl	Picloram
Dalapon	Propachlor
Di(2-ethylhexyl)adipate	Simazine
Di(2-ethylhexyl)phthalates	2,3,7,8-TCDD (Dioxin)
Dicamba	
Dieldrin	**Inorganics**
Dinoseb	Antimony
Diquat	Beryllium
Endothall	Nickel
Glyphosate	Sulfate
Hexachlorobenzene	Thallium
Hexachlorocyclopentadiene	Cyanide
3-Hydroxycarbofuran	

3. **Cadmium.** "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that Cadmium is a health concern at certain levels of exposure. Food and the smoking of tobacco are the common sources of general exposure. This inorganic metal is a contaminant in the metals used to galvanize pipe. It generally gets into drinking water by corrosion of galvanized pipes or by improper waste disposal. This chemical has been shown to damage the kidney in animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Some industrial workers who were exposed to relatively large amounts of this chemical during their working careers also suffered damage to the kidney. EPA has set the enforceable drinking water standard for cadmium at 0.005 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to cadmium."

4. **Chromium.** "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that chromium is a health concern at certain levels of exposure. This inorganic metal occurs naturally in the ground and is often used in the electroplating of metals. It generally gets into water from runoff from old mining operations and improper waste disposal. This chemical has been shown to damage the kidney, nervous system, and the circulatory system of laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Some humans who were exposed to high levels of this chemical suffered liver and kidney damage, dermatitis and respiratory problems. EPA has set the enforceable drinking water standard for chromium at 0.1 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to chromium."

5. **Mercury.** "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that mercury is a health concern at certain levels of exposure.

This inorganic metal is used in electrical equipment and some water pumps. It usually gets into water by improper waste disposal. This chemical has been shown to damage the kidney of laboratory animals such as rats when the animals are exposed at high levels over their lifetimes. EPA has set forth the enforceable drinking water standard for mercury at 0.002 parts per million (ppm) to reduce the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to mercury."

6. **Nitrate.** "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that nitrate poses an acute health concern at certain levels of exposure. Nitrate is used in fertilizer and is found in sewage and wastes from humans and/or farm animals and generally gets into drinking water from those activities. Excessive levels of nitrate in drinking water have caused serious illness and sometimes death in infants under six months of age. The serious illness in infants is caused because nitrate is converted to nitrite in the body. Nitrite interferes with the oxygen carrying capacity of the child's blood. This is an acute disease in that symptoms can develop rapidly in infants. In most cases, health deteriorates over a period of days. Symptoms include shortness of breath and blueness of the skin. Clearly, expert medical advice should be sought immediately if these symptoms occur. The purpose of this notice is to encourage parents and other responsible parties to provide infants with an alternative source of drinking water. Local and State health authorities are the best source for information concerning alternate sources of drinking water for infants. EPA has set the enforceable drinking water standard at 10 parts per million (ppm) for nitrate to protect against the risk of these adverse effects. EPA has also set a drinking water standard for nitrite at 1 ppm. To allow for the fact that the toxicity of nitrate and nitrite are additive, EPA has established a standard for the sum of nitrite and nitrate at 10 ppm. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to nitrate."

7. **Nitrite.** "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that nitrite poses an acute health concern at certain levels of exposure. This inorganic chemical is used in fertilizer and is found in sewage and wastes from humans and/or farm animals and generally gets into drinking water from those activities. While excessive levels of nitrite in drinking water have not been observed, other sources of nitrite have caused serious illness and sometimes death in infants under six months of age. The serious illness in infants is caused because nitrite interferes with the oxygen carrying capacity of the child's blood. This is an acute disease in that symptoms can develop rapidly in infants. However, in most cases, health deteriorates over a period of days. Symptoms include shortness of breath and blueness of the skin. Clearly, expert medical advice should be sought immediately if these symptoms occur. The purpose of this notice is to encourage parents and other responsible parties to provide infants with an alternative source of drinking water. Local and State health authorities are the best source for information concerning alternate sources of drinking water for infants. EPA has set the enforceable drinking water standard at 1 part per million (ppm) for nitrite to protect against the risk of these adverse effects. EPA has also set a drinking water standard for nitrate (converted to nitrite in humans) at 10 ppm and for the sum of nitrite and nitrate at 10 ppm. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to nitrite."

8. **Selenium.** "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that selenium is a health concern at certain high levels of exposure. Selenium is also an essential nutrient at low levels of exposure. This inorganic metal is found naturally in food and soils and is used in electronics, photocopy operations, the

manufacture of glass, chemicals, drugs and as a fungicide and a feed additive. In humans, exposure to high levels of selenium over a long period of time has resulted in a number of adverse health effects including a loss of feeling and control in the arms and legs. EPA has set the enforceable drinking water standard for selenium at 0.05 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to selenium."

9. Acrylamide. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that acrylamide is a health concern at certain levels of exposure. Polymers made from acrylamide are sometimes used to treat water supplies to remove particulates. Acrylamide has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. Sufficiently large doses of acrylamide are known to cause neurological injury. EPA has set the drinking water standard for acrylamide using a treatment technique requirement to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. This treatment technique limits the amount of acrylamide in the polymer and the amount of the polymer which may be added to drinking water to remove particulates. Drinking water systems which comply with this treatment technique have little to no risk and are considered safe with respect to acrylamide."

10. Alachlor. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that alachlor is a health concern at certain levels of exposure. This organic chemical is a widely used pesticide. When soil and climatic conditions are favorable, alachlor may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for alachlor at 0.002 parts per million to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to alachlor."

11. Aldicarb (proposed). "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that aldicarb is a health concern at certain levels of exposure. Aldicarb is a widely used pesticide. Under certain soil and climatic conditions (e.g., sandy soil and high rainfall), aldicarb may leach into groundwater after normal agricultural applications to crops such as potatoes or peanuts, or may enter drinking water as a result of surface runoff. This chemical has been shown to damage the nervous systems of laboratory animals such as rats exposed at high levels over their lifetimes. EPA has set the drinking water standard for aldicarb at 0.003 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to aldicarb."

12. Aldicarb sulfoxide (proposed). "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that aldicarb sulfoxide is a health concern at certain levels of exposure. Aldicarb is a widely used pesticide. Aldicarb sulfoxide in groundwater is primarily a breakdown product of aldicarb. Under certain soil and climatic conditions (e.g., sandy soil and high rainfall), aldicarb sulfoxide may leach into groundwater after normal agricultural applications to crops such as potatoes or peanuts, or may enter drinking

water as a result of surface runoff. This chemical has been shown to damage the nervous systems of laboratory animals such as rats exposed at high levels over their lifetimes. EPA has set the drinking water standard for aldicarb sulfoxide at 0.003 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to aldicarb sulfoxide."

13. Aldicarb sulfone (proposed). "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that aldicarb sulfone is a health concern at certain levels of exposure. Aldicarb is a widely used pesticide. Aldicarb sulfone is formed from the breakdown of aldicarb and is considered for registration as a pesticide under the name aldoxycarb. Under certain soil and climatic conditions (e.g., sandy soil and high rainfall), aldicarb sulfone may leach into groundwater after normal agricultural applications to crops such as potatoes or peanuts, or may enter drinking water as a result of surface runoff. This chemical has been shown to damage the nervous systems of laboratory animals such as rats exposed at high levels over their lifetimes. EPA has set the drinking water standard for aldicarb sulfone at 0.003 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to aldicarb sulfoxide."

14. Atrazine. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that atrazine is a health concern at certain levels of exposure. This organic chemical is a widely used pesticide. When soil and climatic conditions are favorable, atrazine may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for atrazine at 0.002 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to atrazine."

15. Carbofuran. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that carbofuran is a health concern at certain levels of exposure. This organic chemical is a widely used pesticide. When soil and climatic conditions are favorable, carbofuran may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to damage the nervous and reproductive systems of laboratory animals such as rats exposed at high levels over their lifetimes. Some humans who were exposed to relatively large amounts of this chemical during their working careers also suffered damage to the nervous system. Effects on the nervous system are generally rapidly reversible. EPA has set the drinking water standard for carbofuran at 0.04 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to carbofuran."

16. Chlordane. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that chlordane is a health concern at certain levels of exposure. This organic chemical is a pesticide used to control termites. Chlordane is not very mobile in soils. It usually gets into drinking water after application near water supply intakes or wells. When soil and climatic conditions are favorable, chlordane may get into drinking

water by runoff into surface water or by leaching into groundwater. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for chlordane at 0.002 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to chlordane."

17. Dibromochloropropane. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that dibromochloropropane is a health concern at certain levels of exposure. This organic chemical was once a popular pesticide. When soil and climatic conditions are favorable, dibromochloropropane may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for dibromochloropropane at 0.0002 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to dibromochloropropane."

18. o-Dichlorobenzene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that o-dichlorobenzene is a health concern at certain levels of exposure. This organic chemical is used as a solvent in the production of pesticides and dyes. It generally gets into water from improper waste disposal. This chemical has been shown to damage the liver, kidney, and the blood cells of laboratory animals such as rats and mice exposed at high levels during their lifetimes. Some industrial workers who were exposed to relatively large amounts of this chemical during their working careers also suffered damage to the liver, nervous system, and circulatory system. EPA has set the drinking water standard for o-dichlorobenzene at 0.6 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to o-Dichlorobenzene."

19. cis-1,2-Dichloroethylene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that cis-1,2-dichloroethylene is a health concern at certain levels of exposure. This organic chemical is used as a solvent and intermediate in chemical production. It generally gets into water through improper waste disposal. This chemical has been shown to damage the liver, nervous system, and the circulatory system of laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Some humans who were exposed to high levels of this chemical also suffered damage to the nervous system. EPA has set the enforceable drinking water standard for cis-1,2-dichloroethylene at 0.07 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to cis-1,2-dichloroethylene."

20. *trans-1,2-Dichloroethylene* "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that trans-1,2-dichloroethylene is a health concern at certain levels of exposure. This organic chemical is used as a solvent and intermediate in chemical production. It generally gets into water through improper waste disposal. This chemical has been shown to damage the liver, nervous system, and the

circulatory system of laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Some humans who were exposed to high levels of this chemical also suffered damage to the nervous system. EPA has set the enforceable drinking water standard for trans-1,2-dichloroethylene at 0.1 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to trans-1,2-dichloroethylene."

21. 1,2-Dichloropropane. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that 1,2-dichloropropane is a health concern at certain levels of exposure. This organic chemical is used as a solvent and a pesticide. When soil and climatic conditions are favorable, 1,2-dichloropropane may get into drinking water by runoff into surface water or by leaching into groundwater. It may also get into drinking water through improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for 1,2-dichloropropane at 0.005 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to 1,2-dichloropropane."

22. 2,4-D. " The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that 2,4-D is a health concern at certain levels of exposure. This organic chemical is used as a herbicide and to control algae in reservoirs. When soil and climatic conditions are favorable, 2,4-D may get into drinking water by runoff into surface water or by leaching into ground water. This chemical has been shown to damage the liver and kidney of laboratory animals such as rats exposed at high levels over their lifetimes. Some humans who were exposed to relatively large amounts of this chemical during their working careers also suffered damage to the nervous system. EPA has set the drinking water standard for 2,4-D at 0.07 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to 2,4-D."

23. Epichlorohydrin. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that epichlorohydrin is a health concern at certain levels of exposure. Polymers made from epichlorohydrin are sometimes used in the treatment of water supplies as a flocculent to remove particulates. Epichlorohydrin generally gets into drinking water through improper use of these chemicals. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for epichlorohydrin using a treatment technique requirement to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. This treatment technique limits the amount of epichlorohydrin in the polymer and the amount of the polymer which may be added to drinking water as a flocculent to remove particulates. Drinking water systems which comply with this treatment technique have little to no risk and are considered safe with respect to epichlorohydrin."

24. Ethylbenzene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that ethylbenzene is a health concern at certain levels of

exposure. This organic chemical is a major component of gasoline. It generally gets into water by improper waste disposal or leaking gasoline tanks. This chemical has been shown to damage the kidney, liver, and nervous system of laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. EPA has set the enforceable drinking water standard for ethylbenzene at 0.7 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to ethylbenzene."

25. Ethylene dibromide (EDB). "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that EDB is a health concern at certain levels of exposure. This organic chemical was once a popular pesticide. When soil and climatic conditions are favorable, EDB may get into drinking water by runoff into surface water or by leaching into groundwater. It may also get into drinking water through improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for EDB at 0.00005 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to EDB."

26. Heptachlor. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that heptachlor is a health concern at certain levels of exposure. This organic chemical was once a popular pesticide. When soil and climatic conditions are favorable, heptachlor may get into drinking water by runoff into surface water or by leaching into groundwater. It may also get into drinking water through improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for heptachlor at 0.0004 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to heptachlor."

27. Heptachlor epoxide. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that heptachlor epoxide is a health concern at certain levels of exposure. This organic chemical was once a popular pesticide. When soil and climatic conditions are favorable, heptachlor epoxide may get into drinking water by runoff into surface water or by leaching into groundwater. It may also get into drinking water through improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for heptachlor epoxide at 0.0002 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to heptachlor epoxide."

28. Lindane. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that lindane is a health concern at certain levels of exposure. This

organic chemical is used as a pesticide. When soil and climatic conditions are favorable, lindane may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to damage the liver, kidney, nervous system and immune system of laboratory animals such as rats, mice and dogs exposed at high levels over their lifetimes. Some humans who were exposed to relatively large amounts of this chemical during their working careers also suffered damage to the nervous system and circulatory system. EPA has set the drinking water standard for lindane at 0.0002 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to lindane."

29. Methoxychlor. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that methoxychlor is a health concern at certain levels of exposure. This organic chemical is used as a pesticide. When soil and climatic conditions are favorable, methoxychlor may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to damage the liver, kidney, nervous system and reproductive system of laboratory animals such as rats exposed at high levels over their lifetimes. It has also been shown to produce growth retardation in rats. EPA has set the drinking water standard for methoxychlor at 0.04 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to methoxychlor."

30. Monochlorobenzene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that monochlorobenzene is a health concern at certain levels of exposure. This organic chemical is used as a solvent. It generally gets into water from improper waste disposal. This chemical has been shown to damage the liver, kidney, and the nervous system of laboratory animals such as rats and mice exposed at high levels during their lifetimes. EPA has set the drinking water standard for monochlorobenzene at 0.1 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to monochlorobenzene."

31. *Pentachlorophenol* (proposed). "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that pentachlorophenol is a health concern at certain levels of exposure. This organic chemical is used as a wood preservative, herbicide, disinfectant, and defoliant. It generally gets into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to produce adverse reproductive effects and to damage the liver, and kidneys of laboratory animals such as rats exposed at high levels over their lifetimes. Some humans who were exposed to relatively large amounts of this chemical also suffered damage to the liver and kidneys. EPA has set the drinking water standard for pentachlorophenol at 0.001 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water that meets the EPA standard is associated with little to none of this risk and is considered safe with respect to pentachlorophenol."

32. Polychlorinated Biphenyls (PCBs). "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that polychlorinated biphenyls (PCBs) are a health concern at certain levels of exposure. These organic chemicals were once widely used in electrical transformers and other industrial equipment. They generally get into water from improper waste disposal or leaking electrical industrial equipment. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals

also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for PCBs at 0.0005 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to PCBs."

33. Styrene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that styrene is a health concern at certain levels of exposure. This organic chemical is commonly used to make plastics and is sometimes a component of resins used for drinking water treatment. Styrene may get into drinking water from improper waste disposal. This chemical has been shown to damage the liver and the nervous system of laboratory animals such as rats and mice exposed at high levels during their lifetimes. EPA has set the drinking water standard for styrene at 0.1 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to styrene."

34. Tetrachloroethylene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that tetrachloroethylene is a health concern at certain levels of exposure. This organic chemical has been a popular solvent, particularly for dry cleaning. It generally gets into water from improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for tetrachloroethylene at 0.005 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to tetrachloroethylene."

35. Toluene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that toluene is a health concern at certain levels of exposure. This organic chemical is used as a solvent and in the manufacture of gasoline for airplanes. It generally gets into water by improper waste disposal or leaking underground storage tanks. This chemical has been shown to damage the kidney, liver, and nervous system of laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. EPA has set the enforceable drinking water standard for toluene at 0.7 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to toluene."

36. Toxaphene. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that toxaphene is a health concern at certain levels of exposure. This organic chemical was once a pesticide widely used on cotton, corn, soybeans, pineapples, and other crops. When soil and climatic conditions are favorable, toxaphene may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Chemicals which cause cancer in laboratory animals also may increase the risk of cancer in humans who are exposed at lower levels over long periods of time. EPA has set the drinking water standard for toxaphene at 0.003 parts per million (ppm) to reduce the risk of cancer or other adverse health effects which have been observed in laboratory animals. Drinking water that meets this standard is associated with little to none of this risk and is considered safe with respect to toxaphene."

37. 2,4,5-TP. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that toxaphene is a health concern at certain levels of exposure. This organic chemical is used as a herbicide. When soil and climatic conditions are favorable, toxaphene may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to damage the liver and kidney of laboratory animals such as rats and dogs exposed at high levels during their lifetimes. Some industrial workers who were exposed to relatively large amounts of this chemical during their working careers also suffered damage to the nervous system. EPA has set the drinking water standard for 2,4,5-TP at 0.05 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to 2,4,5-TP."

38. Xylenes. "The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that xylenes are a health concern at certain levels of exposure. This organic chemical is used in the manufacture of gasoline for airplanes and as a solvent for pesticides, and as a cleaner and degreaser of metals. It generally gets into water by improper waste disposal. This chemical has been shown to damage the kidney, liver, and nervous system of laboratory animals such as rats and dogs exposed at high levels over their lifetimes. Some humans who were exposed to relatively large amounts of this chemical also suffered damage to the nervous system. EPA has set the enforceable drinking water standard for xylene at 10 parts per million (ppm) to protect against the risk of these adverse health effects. Drinking water which meets this standard is associated with little to none of this risk and should be considered safe with respect to xylenes."

V. VARIANCES AND EXEMPTIONS

Variances and exemptions are available for these compounds. Waivers are also available for the monitoring requirements.

VI. ANALYTICAL METHODS

A. **Asbestos**—USEPA Analytical Method for Determination of Asbestos Fibers in Water, EPA-600/4-83-043, September 1983

B. **Barium**

1. **Method 208.2**—Atomic Adsorption, furnace technique
2. **Method 208.1**—Atomic Adsorption, direct aspiration
3. **Method 200.7**—Inductively-Coupled Plasma

C. **Cadmium**

1. **Method 213.2**—Atomic Adsorption, furnace technique
2. **Method 200.7A**—Inductively Coupled Plasma

D. **Chromium**

1. **Method 218.2**—Atomic Adsorption, furnace technique
2. **Method 200.7**—Inductively-Coupled Plasma

E. **Mercury**

1. **Method 245.1**—Manual Cold Vapor Technique
2. **Method 245.2**—Automated Cold Vapor Technique

F. **Nitrate**

1. **Method 353.3**—Manual Cadmium Reduction
2. **Method 353.1**—Automated Hydrazine Reduction
3. **Method 353.2**—Automated Cadmium Reduction
4. **Method 300.0**—Ion Chromatography
5. **Ion selective electrode**

G. **Nitrite**

1. **Method 354.1**—Spectrophotometric
2. **Method 353.2**—Automated Cadmium Reduction
3. **Method 353.3**—Manual Cadmium Reduction
4. **Method 300.0**—Ion Chromatography

H. **Selenium**

1. **Method 270.3**—Atomic Adsorption, gaseous hydride
2. **Method 270.2**—Atomic Adsorption, furnace technique

I. **Volatile Organic Chemicals**

1. **Method 502.1**—Volatile Halogenated Organic Chemicals in Water by Purge and Trap Gas Chromatography

2. **Method 502.2**—Volatile Organic Chemicals in Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series

3. **Method 503.1**—Volatile Aromatic and Unsaturated Organic Compounds in Water by Purge and Trap Gas Chromatography

4. **Method 524.1**—Measurement of Purgeable Organic Compounds in Water by Purged Column Gas Chromatography/Mass Spectrophotometry

5. **Method 524.2**—Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrophotometry

J. Synthetic Organic Chemicals

1. **Method 504**—1,2-Dibromoethane(EDB) and 1,2-Dibromo-3-chloropropane (DBCP) in Water by Microextraction and Gas Chromatography

2. **Method 505**—Analysis of Organohalide Pesticides and Commercial Polychlorinated Biphenyl Products (Arociors) in Water by Microextraction and Gas Chromatography (for alachlor, atrazine, chlordane, heptachlor, heptachlor epoxide, lindane, methoxychlor, and toxaphene)

3. **Method 507**—Determination of Nitrogen- and Phosphorus-Containing Pesticides in Groundwater by Gas Chromatography with a Nitrogen-Phosphorus Detector (for alachlor and atrazine)

4. **Method 508**—Determination of Chlorinated Pesticides in Water by Gas Chromatography with an Electron Capture Device (for chlordane, heptachlor, heptachlor epoxide, lindane, and methoxychlor)

5. **Method 508A**—Screening for Polychlorinated Biphenyls by Perchlorination and Gas Chromatography (for PCBs expressed as decachlorobiphenyl)

6. **Method 515.1**—Determination of Chlorinated Acids in Water by Gas Chromatography with an Electron Capture Device (for 2,4-D, 2,4,5-TP [Silvex], and pentachlorophenol)

7. **Method 525**—Determination of Organic Compounds in Drinking Water by Liquid-Solid Extraction and Capillary Column Gas Chromatography/Mass Spectrophotometry (for alachlor, atrazine, chlordane, heptachlor, heptachlor epoxide, lindane, methoxychlor, and pentachlorophenol)

8. **Method 531.1**—Measurement of N-Methyl Carbamoyloximes and N-Methyl Carbamates in Water by Direct Aqueous Injection HPLC with Post-Column Derivatization (for aldicarb, aldicarb sulfoxide, aldicarb sulfone, and carbofuran)

VII. TIMETABLE

A. **Proposed Rule:** 22 May 1989

B. **Final Rule:** 30 January 1991

C. **Compliance Dates:** See appropriate sections of the rule.

APPENDIX F: Lead and Copper Rule

I. GENERAL REQUIREMENTS. The Lead and Copper Rule applies to all community water systems and to all nontransient, noncommunity water systems.

A. Maximum Contaminant Level Goals.

1. Lead 0 mg/l
2. Copper 1.3 mg/l

B. Materials Evaluation. Before the system begins a lead and copper sampling program, it must conduct a materials evaluation study. This study determines the materials present in the distribution system through analysis of various records of plumbing materials. From this study, the system must identify a pool of residences subject to a "high risk" of contamination. High risk residences are those with lead solder installed after 1982, homes with lead pipes, and homes with lead service lines.

C. Monitoring. The major requirements of the Lead and Copper Rule are determined by the results of a sampling program. The system must conduct both an initial tap water sampling, and based on the results, must conduct repeat sampling at regular intervals.

1. **Initial Tap Water Sampling.** The initial tap water sampling is conducted by all systems for two consecutive 6 month periods. The date by which this must be completed varies by system size. Those dates are shown in Table F1.

2. **Repeat Monitoring.** Repeat monitoring requirements are based on the results of the initial tap water sampling. Systems which exceed the "action levels" are required to repeat monitoring every 6 months. Systems which meet the action levels may be available to reduce both monitoring frequency and the number of sample sites.

D. Action Levels. Action levels are concentration values which will trigger action by a water system if they are exceeded. An action level is not the same as MCL because exceeding an MCL will trigger punitive action by the regulating body, whereas exceeding an action level only triggers further treatment action on the part of the water system. The water system will only become out of compliance if it does not initiate the steps to reduce contaminant levels.

Action levels are measured against the 90th percentile of lead levels at the consumer's tap. The 90th percentile lead and copper levels are defined as follows:

"The results of all lead or copper samples taken during a monitoring period shall be placed in ascending order from the sample with the lowest concentration to the sample with the highest concentration. Each sampling result shall be assigned a number ascending by single integers beginning with the number 1 for the sample with the lowest contaminant level. The number assigned to the sample with the highest contaminant level shall be equal to the total number of samples taken. The number of samples taken during the monitoring period shall be multiplied by 0.9. The contaminant concentration in the numbered sampled yielded by the above calculation is the 90th percentile contaminant level."[16]

[16] Federal Register, 56 FR 26549, Friday, June 7, 1991.

Table F1

Dates for the First 6-Month Monitoring Period

System Size (# People Served)	First 6 Month Monitoring Period Begins On
>50,000	January 1, 1992
3,301 to 50,000	July 1, 1992
<3,300	July 1, 1993

E. Corrosion Control. Corrosion control is required for all systems serving greater than 50,000 people. Systems serving less than 50,000 will be required to control corrosion if they exceed the lead action levels. EPA had defined a very specific sequence of responsibilities and dates for implementing corrosion control. These steps and dates are described in Section IV: Corrosion Control.

F. Public Education. A system which exceeds the lead action level must begin a public education program. This education program must consist of written materials and broadcast materials with language specified by USEPA. If a significant portion of the system speaks another language than English, information must be bilingual. This language is provided in Section V: Public Notification.

G. Lead Service Line Replacement. If a system cannot meet the lead action levels after installation of corrosion control and source water treatment, USEPA requires the system to begin a lead service line replacement program. After determination of the number of lead service lines from the materials evaluation, a system must replace at least 7 percent of the initial number of lead service lines each year. This corresponds to a fifteen year replacement schedule. The service line must be replaced up to the building inlet. The system may cease replacing lead service lines when it meets the lead action level.

H. Source Water Treatment. Systems which exceed the lead or copper action levels, must sample their source water to determine if source water treatment is necessary. If source water treatment is required by the State, the BATs defined are ion exchange, reverse osmosis, line softening, and coagulation/filtration.

II. BEST AVAILABLE TECHNOLOGY. The BAT identified for the Lead and Copper Rule is a treatment technique composed of four parts: corrosion control, source water reduction, public education, and lead service line replacement. When a system conducts corrosion control studies, it is required to evaluate at least three alternative: pH and alkalinity adjustment, calcium adjustment, and addition of corrosion inhibitors. The BATs identified for source water reduction are: ion exchange, reverse osmosis, lime softening, and coagulation/filtration.

III. MONITORING REQUIREMENTS. The Lead and Copper Rule includes monitoring requirements for lead, copper and other important parameters that may be designated by the State.

A. Initial Tap Water Sampling.

1. Sampling Sites. The selected sampling sites for a community water system must be single family structures which have copper pipes with lead solder installed after 1982, lead pipes, or lead service lines. If multiple family residences make up more than 20 percent of the structure, or if there aren't enough single family homes to complete the pool, multiple family homes which fit the requirements may be included.

A nontransient noncommunity water system may select any building which has copper pipes with lead solder installed after 1982, lead pipes, or lead service lines.

2. Method of Collection. The tap samples collected must be one liter first draw samples after water has been standing for six hours. Service lines samples must be taken after the interior plumbing water has been allowed to run. The sample may be taken after a temperature change in the water, or after a volume equal to the volume of the plumbing between the tap and the line has been flushed.

The system may allow homeowners to collect the samples after they have been instructed by water treatment personnel in the proper method of collection.

3. Timing of Initial Monitoring. Table F1 shows the start dates for the first 6 month monitoring period. Monitoring must be conducted in two consecutive 6 month monitoring periods.

IV. CORROSION CONTROL

A. Steps and Deadlines

1. Large Systems (serving more than 50,000 people). All large systems are required to optimize corrosion control treatment by the following treatment steps and deadlines.

a) January 1, 1993. The systems must conduct initial monitoring during two consecutive 6 month periods by this date.

b) July 1, 1994. The system must complete corrosion control studies by this date.

c) January 1, 1995. The State must designate optimal corrosion control treatment by this date.

d) January 1, 1997. The system must install optimal corrosion control treatment by this date.

e) January 1, 1998. The system must complete followup sampling by this date.

f) July 1, 1998. The state must review installation of treatment and designate optimal water quality parameters by this date.

g) The system must continue to operate in compliance with State-specified optimal water quality control parameters.

2. Small and Medium Systems (serving fewer than 50,000 people). All small and medium systems are required to optimize corrosion control if they do not meet the lead and copper action levels by the following treatment steps and deadlines. The system must conduct monitoring until either it exceeds a lead or copper action level or it becomes eligible for reduced monitoring requirements.

a) 6 months after exceeding an action level. The system must recommend optimal corrosion control treatment.

b) 12 months after exceeding an action level. The State may require a system to perform corrosion control studies.

c) 18 months after exceeding an action level. The State must designate optimal corrosion control treatment for medium systems if the State has not already required corrosion control studies.

d) 24 months after exceeding an action level. The State must designate optimal corrosion control treatment for small systems if the State has not treatment for small systems is the State has not already required corrosion control studies.

e) 18 months after State requires corrosion control studies. The system must complete required corrosion control studies.

f) 6 months after completions of corrosion control studies. The State must designate optimal corrosion control treatment.

g) 24 months after state designates treatment. The system must install corrosion control treatment.

h) 36 months after State designates treatment. The system must conduct followup sampling.

i) 6 months after completion of followup sampling. The State must review the system's installation of treatment and designate optimal water quality control parameters.

B. Corrosion Control Studies. When corrosion control studies are required by the State, the following options must be evaluated: pH and alkalinity adjustment, calcium adjustment, and addition of phosphate or silicate based inhibitors.

V. PUBLIC NOTIFICATION

A. General Requirements. All general public notification requirements apply. In addition, a one time notification is required by the SDWA. If a system cannot meet the lead and copper action levels, it is required to distribute a public education package developed by USEPA.

B. Mandatory Language

1. When lead action levels are exceeded, the following language must be included in all printed materials distributed through its lead education program.

(1) ***Introduction***. The United States Environmental Protection Agency (EPA) and (insert name of water supplier) are concerned about lead in your drinking water. Although most homes have very low levels of lead in their drinking water, some homes in the community have lead levels above the EPA action level of 15 parts per billion (PPB), or 0.015 milligrams of lead per liter of water (mg/l). Under Federal law we are required to have a program in place to minimize lead in your drinking water by (inset date when corrosion control will be completed for your system). This program includes corrosion control treatment, source water treatment, and public education. We are also required to replace each lead service line that we control if the line contributes lead concentrations of 15 ppb or more after we have completed the comprehensive treatment program. If you have any questions about how we are carrying out the requirements of the lead regulation, please give us a call at (insert water system's phone number). This brochure explains the simple steps you can take to protect you and your family by reducing your exposure to lead in drinking water.

(2) ***Health Effects of Lead***. Lead is a common metal found throughout the environment in lead-based paint, air, soil, household dust, food, certain types of pottery porcelain and pewter, and water. Lead can pose a significant risk to your health if too much of it enters your body. Lead builds up in the body over many years and can cause damage to the brain, red blood cells, and kidneys. The greatest risk is to young children and pregnant women. Amounts of lead that won't hurt adults can slow down the normal mental and physical development of growing bodies. In addition, a child at play often comes into contact with sources of lead contamination—like dirt and dust—that rarely affect an adult. It is important to wash children's hands and toys often, and to try to make sure they only put food in their mouths.

(3) ***Lead in Drinking Water***

(i) Lead in drinking water, although rarely the sole cause of lead poisoning, can significantly increase a person's total lead exposure, particularly the exposure to infants who drink baby formulas and concentrated juices that are mixed with water. The EPA estimates that drinking water can make up 20 percent or more of a person's total exposure to lead.

(ii) Lead is unusual among drinking water, contaminants in that it seldom occurs naturally in water supplies like rivers and lakes. Lead enters drinking water primarily as a result of the corrosion, or wearing away of materials containing lead in the water distribution system and household plumbing. These materials include lead-based solder used to join copper pipe, brass and chrome plated faucets, and in some cases, pipes made of lead that connect your house to the water main (service lines). In 1986, Congress banned the use of lead solder containing greater than 0.2 percent lead, and restricted the lead content of faucets, pipes, and other plumbing materials to 8.0 percent.

(iii) When water stands in lead pipes or plumbing containing lead for several hours or more, the lead may dissolve into your drinking water. This means the first water drawn from the tap in the morning, or later in the afternoon, after returning from work or school, can contain fairly high levels of lead.

(4) ***Steps You Can Take in the Home to Reduce Exposure to Lead in Drinking Water.***

(i) Despite our best efforts mentioned earlier to control water corrosivity and remove lead from the water supply, lead levels in some homes or buildings can be high. To find out whether you need to take action in your own home, have your drinking water tested to determine if it contains excessive concentrations of lead. Testing the water is essential because you cannot see taste, or smell lead in drinking water. Some local laboratories that can provide this service are listed at the end of this booklet. For more information on having your water tested, please call (insert phone number of water system).

(ii) If a water test indicates that the drinking water drawn from a tap in your home contains lead above 15 ppb, then you should take the following precautions.

(A) Let the water run from the tap before using it for drinking or cooking any time the water in a faucet has gone unused for more than 6 hours. The longer water resides in your home's plumbing, the more lead it may contain. Flushing the tap means running the cold water faucet until the water gets noticeably colder, usually about 15 to 30 seconds. If your house had a lead service line to the water main, you may have to flush the water for a longer time, perhaps one minute, before drinking. Although toilet flushing or showering flushes water through a potion of your home's plumbing system, you still need to flush the water in each faucet before using it for drinking or cooking. Flushing tap water is a simple and inexpensive measure you can take to protect your family's health. It usually uses less than one or two gallons of water and costs less than (insert a cost estimate based on flushing two times a day for 30 days) per month. To conserve water, fill a couple of bottles for drinking water after flushing the tap, and whenever possible, use the first flush water to wash dishes or water the plants. If you like in a high-rise building, letting the water flow before using it may not work to lessen your risk from lead. the plumbing systems have more, and sometimes larger pipes than smaller buildings. Ask your landlord for help in locating the source of the lead and for advice on reducing the lead level.

(B) Try not to cook with, or drink water from the hot water tap. Hot water can dissolve more lead more quickly than cold water. If you need hot water, draw water from the cold tap and heat it on the stove.

(C) Remove loose lead solder and debris from the plumbing materials installed in newly constructed homes, or homes in which the plumbing has recently been replaced, by removing the faucet strainers form all taps and running the water from 3 to 5 minutes. Thereafter, periodically remove the strainers and flush out any debris that has accumulated over time.

(D) If your copper pipes are joined with lead solder that has been installed illegally since it was banned in 1986, notify the plumber who did the work and request that he or she replace the lead solder with lead-free solder. Lead solder looks dull gray, and when scratched with a key, looks shiny. In addition, notify your State (insert name of department responsible for enforcing the Safe Drinking Water Act in your State) about the violation.

(E) Determine whether or not the service line that connects your home or apartment to the water main is made of lead. The best way to determine of your service line is made of lead is by either hiring a licensed plumber to

inspect the line or by contacting the plumbing contractor who installed the line. You can identify the plumbing contractor by checking the city's record of building permits which should be maintained in the files of the (insert name of department that issues building permits). A licensed plumber can at the same time check to see if your home's plumbing contains lead solder, lead pipes or pipe fitting that contain lead. The public water system that delivers water to your home should also maintain records of the materials located in the distribution system. If the service line that connects your dwelling to the water main contributes more than 15 ppb to drinking water, after our comprehensive treatment program is in place, we are required to provide you with information on how to replace your portion of the service line, and offer to replace that portion of the line at your expense and take a follow-up tap water sample within 14 days of the replacement. Acceptable replacement alternatives include copper, steel, iron, and plastic pipes.

(F) Have an electrician check your wiring. If grounding wires from the electrical system are attached to your pipes, corrosion may be greater. Check with a licensed electrician, or your wiring can be grounded elsewhere. DO NOT attempt to change the wiring yourself because improper grounding can cause electrical shock and fire hazards.

(iii) The steps described above will reduce the lead concentrations in your drinking water. However, if a water test indicates that the drinking water coming from your tap contains lead concentrations in excess of 15 ppb after flushing, or after we have completed our actions to minimize lead levels, than your may want to take the following additional measures:

(A) Purchase or lease a home treatment device. Home treatment devices are limited in that each unit treats only the water that flows from the faucet to which it is connected, and all of the devices require periodic maintenance and replacement. Devices require periodic maintenance and replacement. Devices such as reverse osmosis systems or distillers can effectively remove lead from your drinking water. Some activated carbon filters may reduce lead levels at the tap, however, all lead reduction claims should be investigated. Be sure to check the actual performance of a specific home treatment device before and after installing the unit.

(B) Purchase bottled water for drinking and cooking.

(iv) You can consult a variety of sources for additional information. Your family doctor or pediatrician can perform a blood test for lead and provide you with information about the health effects of lead. State and local government agencies that can be contacted include:

(A) (insert the name of city or county department of public utilities) at (insert phone number) can provide you with information about your community's water supply and a list of local laboratories that have been certified by the EPA for testing water quality;

(B) (insert the name of city or county department that issues building permits) at (insert phone number) can provide you with information about building

permit records that should contain the names of plumbing contractors that plumbed your home; and

(C) (insert the name of the State Department of Public Health) at (insert phone number) or the (insert the name of the city or county health department) at (insert phone number) can provide you with information about the health effects of lead and how you can have your child's blood tested.

(v) The following is a list of some State approved laboratories in your area that you can call to have your water tested for lead. (Insert names and phone numbers of at least two laboratories).

2. The following language must be included in all public service announcements submitted to radio and television for broadcasting:

"Why should everyone want to know the facts about lead and drinking water? Because unhealthy amounts of lead can enter drinking water through the plumbing in your home. That's why I urge you to do what I did. I had my water tested for (insert free, or $ per sample). You can contact the (insert the name of the city or water system) for information on testing and on simple ways to reduce your exposure to lead in drinking water".

3. When lead or copper action levels are exceeded, or other instances requiring public notification, the following language must be included in the public notice.

Lead. The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that lead is a health concern at certain exposure levels. Materials that contain lead have frequently been used in the construction of water supply distribution systems, and plumbing systems in private homes and other buildings. The most commonly found materials include service lines, pipes, brass and bronze fixtures, and solders and fluxes. Lead in these materials can contaminate drinking water as a result of the corrosion that takes place when water comes into contact with these materials. Lead can cause a variety of adverse health effects in humans. At relatively low levels of exposure, these effects may include interference with red blood cell chemistry, delays in normal physical and mental development in babies and young children, slight deficits in the attention span, hearing, and learning abilities of children, and slight increases in the blood pressure of some adults. EPA's national primary drinking water regulation requires all public water systems to optimize corrosion control to minimize lead contamination resulting from the corrosion of plumbing materials. Public water systems serving 50,000 or fewer that have lead concentrations below 15 parts per billion (ppb) in more than 90 percent of tap water samples (the EPA "action level") have optimized their corrosion control treatment. Any water system that exceeds the action level must also monitor their source water to determine whether treatment. Any water system that continues to exceed the action level after installation of corrosion control and/or source water treatment must eventually replace all lead service lines contributing in excess of 15 ppb of lead to drinking water. Any water system that exceeds the action level must also undertake a public education program to inform consumers of ways they can reduce their exposure to potentially high levels of lead in drinking water.

Copper. The United States Environmental Protection Agency (EPA) sets drinking water standards and has determined that copper is a health concern at certain exposure levels.

Copper, a reddish-brown metal, is often used to plumb residential and commercial structures that are connected to water distribution systems. Copper contaminating drinking water as a corrosion byproduct occurs as the result of the corrosion of copper pipes that remain in contact with water for a prolonged period of time. Copper is an essential nutrient, but at high doses it has been shown to cause stomach and intestinal distress, liver and kidney damage, and anemia. Persons with Wilson's disease may be at higher risk of health effects due to copper than the general public. EPA's national primary drinking water regulation requires al public water systems to install optimal corrosion control to minimize copper contamination resulting from the corrosion of plumbing materials. Public water systems serving 50,000 people or fewer that have copper concentrations below 1.3 parts per million (ppm) in more than 90 percent of tap water samples (the EPA "action level") are not required to install or improve their treatment. Any water system that exceeds the action level must also monitor their source water to determine whether treatment to remove copper in source water is needed.

VI. VARIANCES AND EXEMPTIONS. Variance and exemptions may be granted for the requirements of the Lead and Copper Rule. If a State grants a variance or exemption from the lead or copper action levels, it may require the system to use bottled water or point-of-use devices as a condition of the variance. The system may not use a point of entry device for a variance from the corrosion control requirements. If the State grants a variance or exemption from the source water treatment or lead service line replacement devices, or point of entry devices.

If a system uses bottled water, it must provide a monitoring program to ensure that the bottled water meets all MCLs.

VII. ANALYTICAL METHODS

A. **Lead**
   1. **Method 239.2**—Atomic adsorption, furnace technique
   2. **Method 200.8**—Inductively-coupled plasma, mass spectrometry
   3. **Method 200.9**—Atomic Adsorption, platform furnace technique

B. **Copper**
   1. **Method 220.2**—Atomic Adsorption, furnace technique
   2. **Method 220.1**—Atomic Adsorption, direct aspiration
   3. **Method 200.7**—Inductively-coupled plasma
   4. **Method 200.8**—Inductively-coupled plasma, mass spectrometry
   5. **Method 200.9**—Atomic Adsorption, platform furnace

VIII. TIMETABLE

A. **Proposed Rule**: 18 August 1988
B. **Final Rule**: 7 June 1991

APPENDIX G: Disinfection Byproducts Strawman Rule

I. GENERAL REQUIREMENTS

A. Maximum Contaminant Levels and Maximum Contaminant Level Goals. MCLGs and MCLs could be set for the following:

1. Total trihalomethanes (TTHM)—lead options are 50 μg/l or 25 μg/l
2. Haloacetic acids
3. Chlorine dioxide, chlorite, chlorate
4. Chlorine and Chloramine.
5. Chloropicrin
6. Cyanogen Chloride
7. Hydrogen peroxide, bromate, iodate
8. Formaldehyde

B. Treatment Technique Requirements or Guidance. Treatment techniques could be required for the following, or EPA might provide guidance:

1. MX (as a surrogate for mutagenicity)
2. Total oxidizing substances
3. Assimilable organic carbon

II. BEST AVAILABLE TECHNOLOGIES

A. Precursor Removal. Options considered are conventional treatment modifications and GAC. Membranes may not be BAT because of lack of fullscale experience.

B. Alternate Oxidants. Options considered are chlorine dioxide and chlorite residual removal, and ozone plus chloramines. It is believed that a TTHM standard of 25 μg/l is the lowest that allows continued use of free chlorine.

C. Byproduct Removal. Options being considered are aeration (for some), GAC adsorption, and reducing agents.

III. INTERACTION WITH OTHER RULES

A. Surface Water Treatment Rule. Turbidity requirements must be met. Therefore, there is concern for precursor removal and ozontation prior to filtration. The SWTR requires a residual of 0.2 mg/l at the entry to the distribution system; a detectable residual is required in the distribution system. The free chlorine residual affects the rate of formation and the level of disinfection byproducts. The alternative use of chloramines to decrease trihalomethanes (THMs) may not be universally acceptable.

B. Lead and Copper Rule. In order to control corrosion, pH adjustment will be practiced. A pH greater than 8 will favor THM formation, and suppress acids and others. For free chlorine, higher CT values are required at higher pH. Removal of organics may improve corrosion control.

C. Synthetic Organic Chemicals Rules. Compatible definition of GAC as BAT. Avoid chlorination prior to GAC because chlorine reacts with GAC.

IV. TIMETABLE

A. Proposed Rule: June 1993

B. Final Rule: December 1994

APPENDIX H: Case Studies

This appendix presents four case studies to demonstrate the effects of the new SDWA Amendments on Army water treatment plants. Cases Alpha, Beta, and Gamma are actual installations. The worst-case example is a composite example with serious potential treatment problems.

The actual case studies illustrate treatment problems ranging from corrosion control required by the Lead and Copper Rule to filtration required by the Surface Water Treatment Rule. Issues addressed by the worst-case scenario include reduction of disinfection byproducts and removal of VOCs from groundwater.

I. CASE 1: FORT ALPHA

A. Background

1) **General.** This treatment system is located in a coastal region with temperate weather. The system serves a population of about 23,000 personnel, but that number fluctuates throughout the year.

2) **Pumping Capacity.** Fort Alpha uses an underground spring supply, Sigma Spring, which feeds into a lake. A holding pond has been constructed to separate the spring from the lake. The spring feeds directly into the holding pond, and when it reaches an overflow level, spills into the lake. During the winter, this spring can be pumped at up to 9300 gallons per minute (gpm).* During the late summer, the spring supply can be pumped only at about 4500 gpm. When demand exceeds the capacity of the spring, the spring is supplemented by eight wells. The total pumping capacity of the wells is 7250 gpm. An additional 1900 gpm capacity is available in emergencies from two additional wells with certain undesirable water qualities.

3) **Water Quality and Treatment.** The spring water has low turbidity (0.4-0.5 NTU), low pH (6.4 - 6.7), a negative Langelier index (-1.6) due to dissolved carbon dioxide (21 to 25 mg/l), and is a soft water (hardness 40-50 mg/l as $CaCO_3$). These characteristics help make the spring water highly corrosive.

The well water quality varies depending on specific well characteristics such as depth, aquifer characteristics, and screen length. Table H1 describes the various wells serving Fort Alpha. In general, all wells undergo treatment consisting of chlorination and fluoridation only. The water quality at several of the wells is described in Table H2.

At present, the only treatment provided for Sigma Spring and all wells is chlorination and fluoridation. Corrosion control is not provided.

B. New Treatment Plant. A new treatment plant for Sigma Spring is at the 35 percent design phase. To control corrosion, this plant will provide packed-tower aeration to remove CO_2. This plan does not include a filtration process or any contingency plans to install filtration. Since the original design of the new water treatment plant, the Surface Water Treatment Rule and the Lead

* 1 gpm = 3.785 liters per minute.

Table H1

Well Characteristics

Well	Capacity (gpm)	Comments
6	1400	An older, fully screened, deep well
8	900	An older, fully screened deep well used only in emergency situations because the upper aquifer is contaminated with trichloroethylene (TCE) and the water has undesirable aesthetic qualities
9	110	A shallow independent well that serves the golf course
10	35	A deep independent well that serves an ammo supply point
12A & 12B	3600	Shallow wells, in close proximity, that share the same source
13	950	A deep well
14	1000	A deep well
16	1000	A deep well used only in emergencies due to contamination by TCE and poor aesthetic qualities
17	450	A deep well
19A & 19B	800	New deep wells

and Copper Rule have been finalized. These new regulations will impact the design of the treatment plant. The SWTR may require filtration in the future. Before construction begins on the new plant, the State should determine whether filtration will be necessary in order to avoid expensive retrofitting directly after the plant is finished.

C. Potential Effects of the New SDWA Requirements. To meet the requirements of the Safe Drinking Water Act, Fort Alpha must address two main issues: (1) filtration may be required depending on the designation of the water source or the ability to meet the requirements for avoiding filtration, and (2) corrosion control may be required due to the low pH of the source water. Source water treatment of one well may also be necessary.

1) Spring Water Type Designation and Filtration Requirements. Currently, Sigma Spring is designated a surface water source. A cover for the spring is under construction. After the cover is completed, the State will designate the spring a groundwater source. The addition of the cover may prevent the spring from requiring filtration under the Surface Water Treatment Rule (SWTR). Whether the spring will be designated as groundwater under the influence of surface water is unknown. If the spring is designated as groundwater under the influence of surface water, it is not known whether the system could meet the requirements for avoiding filtration.

Groundwater under the influence of surface water is defined as any water underneath the surface of the ground with one of two characteristics:

- Significant presence of insects or other macroorganisms, algae, organic debris, or large-diameter pathogens such as *Giardia*, or

- Significant or relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH that closely correlate to climatological or surface water conditions.

Table H2

Well Water Quality Characteristics

Well	pH	Langelier Index	Total Dissolved Solids (mg/l)	Hardness (mg/l as $CaCO_3$)
6	6.72	-1.41	120	98
12A	6.81	-1.56	90	68
12B	6.88	-1.54	78	85
13	7.31	-1.02	82	77
14	7.40	-1.18	94	56
19A	7.49	-1.10	72	56
19B	6.86	-1.67	74	64

The primacy agent (State) must determine whether the spring is under the influence of surface water. The spring cover will protect the spring from contamination by macroorganisms. The cover will also protect the spring from surface runoff that could cause fluctuations in the water's characteristics. Only those subsurface sources at risk of contamination by *Giardia* will be subject to the requirements of the SWTR.

The SWTR requires all surface water sources to filter their water. Fort Alpha is currently designated a surface water source, but construction of the spring cover will reclassify the plant as a groundwater source. This reclassification has been approved by the State. The spring may still be designated groundwater under the influence of surface water instead of a groundwater source because the State has not yet adopted guidelines for determination of the difference. Groundwater under the influence of surface water must be filtered.

The possibilities for Fort Alpha are as follows:

a) Designation as groundwater source, thus not requiring filtration

b) Designation as groundwater under the influence of surface water, not meeting the requirements to avoid filtration, thus requiring filtration, or

c) Designation as groundwater under the influence of surface water that meets the requirements to avoid filtration, thus not requiring filtration.

The requirements to avoid filtration for surface water or groundwater under the influence of surface water are explained in Appendix C. Included in these requirements is a requirement for redundant disinfection capability or an automatic water shutoff when the disinfection residual in the distribution system falls below 0.20 mg/l. If Fort Alpha tried to meet the requirements to avoid filtration, either an automatic shutoff or redundant disinfection would be required. Redundant disinfection would have to be provided at the treatment plants for each of the nine sources regularly used.

2) **Corrosion Control.** The new Lead and Copper Rule requires corrosion control for all systems serving more than 50,000 people, and for all systems (regardless of size) that do not meet the action levels for lead and copper. The action levels are as follows:

a) The lead level in more than 5 percent of the samples is more than 0.015 mg/l
b) The copper level in more than 5 percent of the samples is more than 1.3 mg/l.

Fort Alpha water has a low pH and a high CO_2 concentration. The new water treatment plant design incorporates a stripping tower to remove dissolved CO_2. Removing CO_2 will increase the pH, which will help prevent corrosion.

3) **Source Water Treatment.** Exceeding the action levels for lead or copper triggers source water treatment. If Fort Alpha exceeds the action level for copper, the system will have to install source water treatment for one particular well, which has a high copper level of 2.1 mg/l.

II. CASE 2: FORT BETA

A. Background. Fort Beta operates three water systems: North Post, South Post, and Airfield. All three systems currently use groundwater sources and will probably continue to be designated groundwater sources. At present, Airfield is not designated a PWS, and therefore does not fall under the Safe Drinking Water Act.

1) **North Post.** The North Post system consists of 12 wells, each with a capacity of 300 gpm. There are two storage reservoirs: a low-level one and a high-level one. Two booster pumps pump at 2800 gpm and one pumps at 1400 gpm from low to high storage. There is one 1400 gpm gasoline engine pump on standby.

The pH is generally around 7, the total alkalinity is about 100 mg/l as $CaCO_3$, and the total hardness is about 100 mg/l as $CaCO_3$. VOC surveys have been performed, but with nondetect results.

Current treatment includes chlorination, fluoridation, and addition of "Aqua-Mag" polyphosphate to inhibit corrosion.

2) **South Post.** The South Post system consists of two wells each with a capacity of 200 gpm. There is one high-level reservoir.

The pH stays consistently at 6.2. Treatment includes only chlorination at the wellhouse.

B. Potential Effect of the New SDWA Requirements. Under SDWA, the treatment plants at Fort Beta will have to meet the upcoming Groundwater Disinfection Rule by achieving a specified inactivation of microorganisms. Because of the low pH at the South Post, corrosion control treatment may be necessary.

The system is currently designing a site sampling plan for coliform, which will bring it into compliance with the Total Coliform Rule.

1) **Corrosion Control.** The new Lead and Copper Rule requires corrosion control for all systems serving more than 50,000 people, and for all systems not meeting the action levels. The action levels are as follows:

a) The lead level in more than 5 percent of samples is more than 0.015 mg/l

b) The copper level in more than 5 percent of samples is more than 1.3 mg/l

Since corrosion control is already implemented at the North Post, the South Post is the only system where corrosion control will be necessary. Before a decision about corrosion control can be made, the installation must complete an initial tap water sampling program. The first 6-month monitoring period begins on 1 July 1993 for systems serving fewer than 3300 people. The steps towards completing the initial tap sampling include a materials survey.

2) **Disinfection Requirements.** The Groundwater Disinfection Rule will require all groundwater systems to achieve a specific CT value for disinfection. This rule will affect all groundwater systems.

III. CASE 3: FORT GAMMA

A. Background. Fort Gamma uses a surface water source with conventional treatment. The maximum design flow rate for the treatment plant is 10 million gallons per day (MGD),* with an average flow of 5 MGD. The raw water has a relatively low pH of 5.0 and a low Langelier index of -6.0. After treatment the pH is about 7 to 7.5, and the Langelier index of about -2.0 to -1.0. The alkalinity of the raw water is about 5 mg/l as $CaCO_3$, and after treatment is 10 to 15 mg/l. Fort Gamma uses a conventional treatment plant with coagulation, flocculation, sedimentation, and filtration. After the raw water is pumped in, powdered activated carbon (PAC), chlorine, lime, and alum are fed into the rapid mix basin. Chlorine is dosed at 3 mg/l. Lime and alum, the coagulants used for flocculation, are dosed at 7 mg/l, and 23 mg/l respectively. The PAC is dosed at 1 mg/l. Mixing continues for 21 minutes. Flocculation is performed for about 55 minutes, at a flow rate of 5 MGD. Retention time in the sedimentation basin in approximately 12 hours.

B. Potential Effects of the New SDWA Requirements. Since Fort Gamma uses a surface water source, the treatment plant is subject to all rules promulgated so far: VOCs, Fluoride, Total Coliform, Surface Water Treatment, and SOCs and IOCs (Phase II). Most of the applicable requirements for the Fluoride Rule, the VOCs Rule, and the SOCs and IOCs Rule involve the monitoring. Changes in treatment might be required to comply with the Total Coliform Rule and the Surface Water Treatment Rule.

1) **The VOCs Rule.** The VOCs Rule regulates eight organic chemicals and requires the monitoring of many unregulated contaminants. Since the source water does not contain any of the regulated contaminants, the primary requirements of this rule are the monitoring for both regulated and unregulated contaminants. Surface waters are not generally contaminated by VOCs.

* 10 MGD = 37.85 million liters/day.

2) **The Fluoride Rule**. The Fluoride Rule regulates fluoride that is present both naturally and artificially. Fort Gamma fluoridates its water to a level of 1.2 mg/l. This level is below both the MCL and the SMCL. Monitoring is required yearly.

3) **The Total Coliform Rule**. The Total Coliform Rule has monitoring as its major requirement. Fort Gamma collects more than 40 samples per month, therefore its MCL allows no more than 5 percent of those samples to be total coliform positive.

4) **The Surface Water Treatment Rule**. The Surface Water Treatment Rule requires filtration and disinfection of surface water supplies. Fort Gamma already provides both these treatments. However, both treatment processes must meet the operating criteria specified in this rule. Fort Gamma uses dual media conventional filtration. The assumed log removals of *Giardia* and viruses are 2.5 and 2.0 respectively for conventional filtration. Therefore the recommended minimum level of disinfection is 0.5 log removal for *Giardia* and 2.0 log removal for viruses.

Fort Gamma uses free chlorine for primary disinfection, and chloramines to go out in the distribution system. Free chlorine is much more effective in virus removal than in *Giardia* removal, and a short CT of 2-6 will provide the required 2 log removal. *Giardia* is thus the controlling factor for required CT as long as the free chlorine disinfection provides the required CT for virus removal. If the free chlorine disinfection does not provide the required CT for viruses, removal of viruses could become the controlling factor, because chloramines are more effective in removing *Giardia* than viruses.

At this time, a tracer study has not been performed for this plant. A study is planned in the near future to determine the CT at which the plant operates. The Surface Water Treatment Rule requires performance of a tracer study.

To summarize, the important requirements of the SDWA Amendments for this treatment plant are primarily those of the SWTR. This plant must perform a tracer study to determine if any alterations to the plant are necessary to achieve the required CT values.

IV. CASE 4: WORST-CASE SCENARIO

A. Background. In this hypothetical worst-case scenario, a system falls under the contradictory regulations of several rules. This system uses both surface water and groundwater. The surface water source is used all year, with the groundwater used as a supplement during the summer. Currently, surface water treatment consists of prechlorination, coagulation, flocculation, sedimentation, rapid sand filtration, and postchlorination. The groundwater is treated with air stripping to remove TCE, and then chlorinated.

B. Surface Water Treatment. The surface water has a relatively high level of organics, which may lead to problems with disinfection byproducts. The system is meeting the THM standard presently but will probably not be able to meet the lower levels of the new standard while using both pre- and postchlorination. In addition, the filtration process will have to be upgraded to meet the operating standards of the SWTR.

Several options are available to reduce the THM level in the surface water. The most common are moving the point of chlorination, using alternative disinfectants, removal of the THM precursors, and removal of the THMs themselves. Because THMs continue to form over a period

of time, removing them at the plant does not guarantee that they will not continue to form in the distribution system. Removing THM precursors is a more effective way to prevent the formation of THMs.[17]

Several techniques are available to remove THM precursors, including clarification, aeration, oxidation, adsorption, ion exchange, biologic degradation, and lowering of pH. To be effective, precursor removal has to be performed before chlorine is added.

Optimization of the coagulation and flocculation process can improve removal of organic matter. This worst-case system has already improved the coagulation process to meet the current THM standard.

Preoxidation of the organic matter can reduce the levels of THMs formed. Several oxidants are commonly used for this treatment: chlorine dioxide, ozone, and advanced oxidation processes such as ozone in combination with ultraviolet (uv) light or hydrogen peroxide.

Ozone can break down larger organic molecules into smaller, more biodegradable ores. Ozone used for oxidation must be followed by a filtration or an adsorption process to prevent microbiological problems in the distribution system. Ozone followed by GAC may be a viable alternative.

Adsorption of organic compounds can be achieved with PAC or GAC. PAC can be added before filtration, but cannot be added with chlorine because PAC reacts with chlorine.

This system will probably have to change its disinfection techniques. At a minimum, chloramines will be used to take a disinfectant residual out into the distribution system.

This system will need to upgrade its filtration process. The system will change from a single-media rapid sand filtration to a dual-media rapid granular filtration. The filter media will be replaced by anthracite and sand.

C. Groundwater Treatment. The groundwater system will have to meet the upcoming regulations of the Groundwater Disinfection Rule and continue to remove TCE. The pH of the groundwater is fairly low—6.5—so corrosion control may be necessary.

The two common methods of removing VOCs are stripping and GAC adsorption. The system is currently using stripping to remove TCE. The stripping process adds oxygen to the water which can increase corrosiveness, which may impair the system's ability to comply with the Lead and Copper Rule. Oxygen reduction is often used as a technique to control corrosion.

Since the surface water plant will be installing GAC to remove THM precursors, this process might also be used to remove TCE. A bench scale or pilot study would be necessary to determine whether the GAC could work for both functions. The groundwater could be pumped to the surface water plant and blended before treatment, or blended further down the treatment process.

Since the pH of the groundwater is lower than that of the surface water, the blended water might have a different pH than the surface water, depending on the buffering capacity of either water. Also, the pH might vary from summer to winter, thus affecting corrosion control techniques.

[17] *Treatment Techniques for Controlling Trihalomethames in Drinking Water* (AWWA, 1982), Chapter 7.

V. SUMMARY

Monitoring requirements of the new rules are extensive. Under the VOCs Rule, systems must monitor for unregulated organics. Under the Total Coliform Rule, systems must change their monitoring to presence/absence testing and provide a site sampling plan to the State. Under the Surface Water Treatment Rule, surface water systems and groundwater systems under the influence of surface water must perform tracer studies to determine the contact time for disinfection. The Lead and Copper Rule requires a materials survey and an initial tap water sampling program to be performed.

Many requirements will overlap with requirements of other rules. The most notable overlap is between the Surface Water Treatment Rule and the Disinfection/Disinfection Byproducts Rule. The SWTR requires a minimum disinfection level and the D/DBP Rule will limit the allowable level of disinfection byproducts. Other overlaps occur between the SWTR and the Lead and Copper Rule. Many disinfectants work more efficiently at lower pH levels, but for corrosion control the pH level must be elevated.

APPENDIX I: Projected Cost of Army Compliance With SDWA Amendments

Overview of Analysis Approach

Projections of environmental compliance costs were developed using information on recent Army operation and maintenance costs and through the identification and application of environmental compliance implementation measures and cost factors obtained from a military environmental compliance estimating methodology.

Methodology and Assumptions

Three cost components were defined in order to represent the Army environmental compliance costs associated with drinking water management. They are as follows:

1. Operating and maintenance (O&M) costs for existing drinking water systems
2. Incremental additional costs for achieving environmental compliance with existing regulations
3. Incremental additional costs for achieving environmental compliance with future regulations.

Existing Systems O&M

Assumptions and methodology for calculating O&M costs for existing systems were developed as follows:

- 1989 O&M data were obtained from the *Facilities Engineering and Housing Annual Summary of Operations* (the "Red Book") and for the following water supply sources: wells, surface water, outside utility, and distribution.
- The total 1989 O&M costs were then indexed to 1991 dollars and assumed to remain constant across the decade (thus assuming no increase or decrease in facilities/water demand).

Incremental Additions to Meet Existing Regulations

Assumptions and methodology for calculating incremental additional costs for achieving environmental compliance with existing regulations were developed as follows:

- The total number of Army bases requiring upgrades to achieve compliance with existing regulations was estimated by assuming that the Army has the same percentage of bases requiring upgrade as does the Air Force and similar compliance deficiencies (and thus needed systems) exist between the two services.
- A military environmental compliance estimating methodology was applied to estimate compliance costs for Planning & Development (P&D), necessary capital improvements (CI), and incremental additional O&M for the new systems.
- Planning and implementation of the upgrades to meet existing regulations were assumed to occur across the 1991-1995 timeframe. Association O&M costs continue through the end of the decade.

CI costs were estimated from data that define process costs as a function of both process type and volume throughput to be treated. The specific treatment deficiencies (and thus required treatment processes) were assumed to be the same as typically required to upgrade Air Force facilities. 1989 water throughput volumes for the Army (from the "Red Book") were used to calculate costs. Total construction costs were estimated to be 44 percent higher to reflect costs for non-process "balance of systems/plant." Full compliance is reached by 1995.

P&D costs were assumed to be 11 percent of total CI costs and also incurred during the 1991-1995 timeframe.

O&M costs were estimated using data from a military environmental compliance estimating methodology that defined O&M costs for the various processes implemented and as a function of Army volume flow throughput.

Incremental Additions to Meet Future Regulations

Assumptions and methodology for calculating incremental additional costs for achieving environmental compliance with future regulations were developed as discussed below.

> Planning and implementation of the upgrades to meet future regulations were estimated in the same fashion as costs to meet existing regulations. However, those specific processes associated with future regulations were used to estimate CI and O&M costs. Also, CI and P&D costs were assumed to be slightly delayed (from the timeframe recommended in the military environmental compliance estimating methodology) to reflect more probable estimates of available funding and time requirements to implement the needed systems. CI and P&D costs were assumed to occur in the 1996-2000 timeframe. Associated O&M costs are incurred in the 1998-2000 timeframe.

Table I1 summarizes all categories of projected costs for 1991 through 2000. Figure I1 graphs projected year-to-year cost totals for complying with the SDWA Amendments.

Table I1

Projected Army Safe Drinking Water Program Costs

SAFE DRINKING WATER

THOUSANDS OF 1991 DOLLARS

CATEGORY	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	TOTAL
Existing Regulations											
Operation & Maintenance	130740	131730	141090	143910	151100	153370	155670	158010	160380	162780	$1,488,780
Planning & Design	1890	2140	2820	930	930	0	0	0	0	0	8,710
Capital Improvement	18530	21050	27700	9140	9140	0	0	0	0	0	85,560
SUBTOTAL	151160	154920	171610	153980	161170	153370	155670	158010	160380	162780	1,583,050
Future Regulations											
Operation & Maintenance	0	0	0	0	900	1000	4360	4500	4640	4770	20,170
Planning & Design	0	0	370	370	1660	1300	1300	0	0	0	5,000
Capital Improvements	0	0	3940	3940	17120	13180	13180	0	0	0	51,360
SUBTOTAL	0	0	4310	4310	19680	15480	18840	4500	4640	4770	76,530
Management	1500	1520	1530	1530	1560	1590	1610	1640	1670	1700	15,850
TOTAL	152,660	156,440	177,450	159,820	182,410	170,440	176,120	164,150	166,690	169,250	$1,675,430

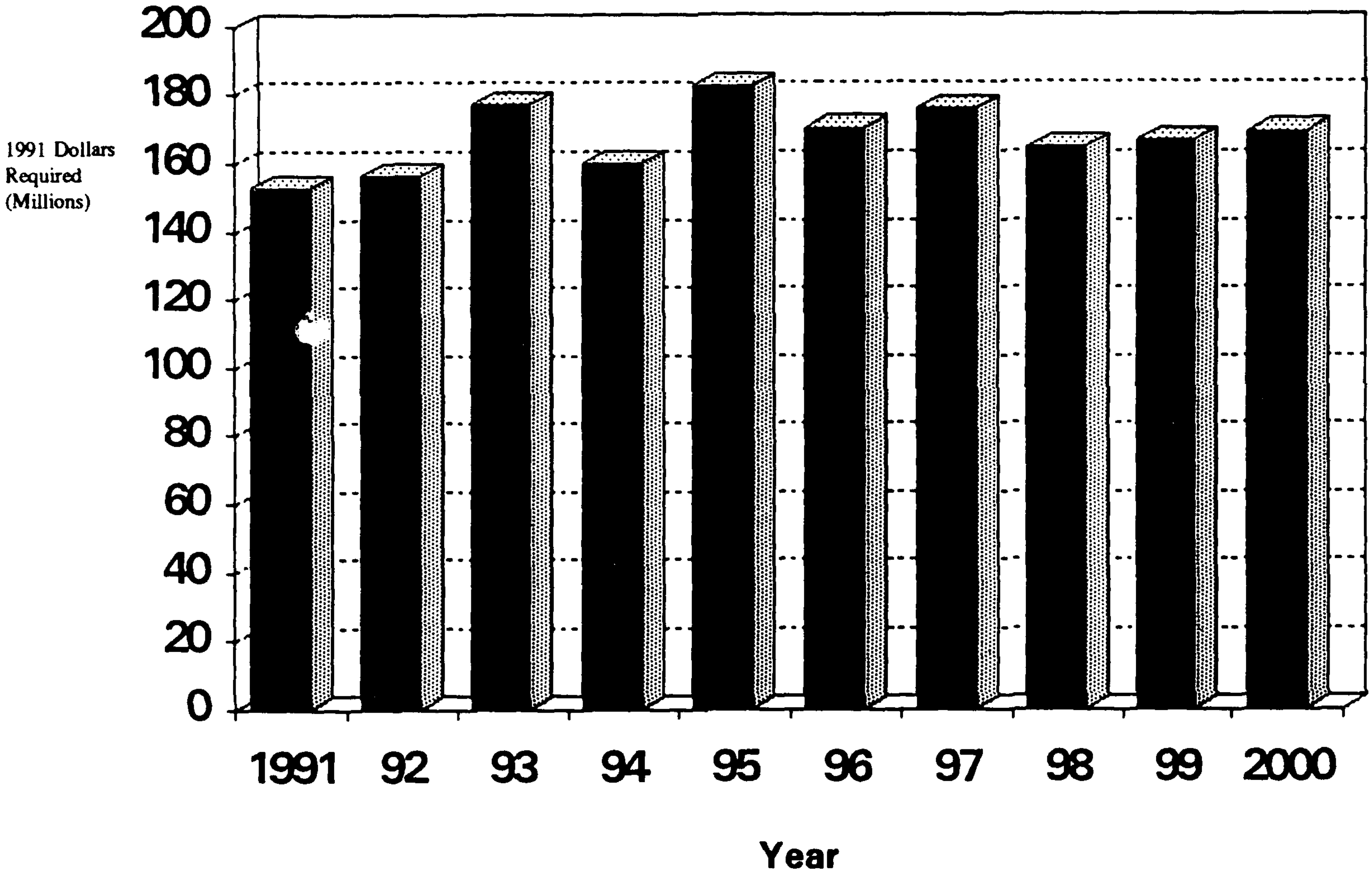

Figure 11. Projected Army Safe Drinking Water Program Costs.

APPENDIX J: Bibliography of Information Sources

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VOCs Rule

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Surface Water Treatment Rule

54 FR [illegible]	29 June 1989	*Surface Water Treatment Rule–Final Rule*

Total Coliform Rule

56 FR 1556	15 January 1991	*Partial Stay of Certain Provisions of Final Rule*
56 FR 636	8 January 1991	*Analytical Techniques: Coliform Bacteria—Final Rule*
55 FR 22752	1 June 1990	*Analytical Techniques: Coliform Bacteria—Proposed Rule*
54 FR 27544	29 June 1989	*Total Coliform Rule—Final Rule*

SOCs and IOCs

56 FR 3526	30 January 1991	*SOCs and IOCs (Phase II) Final Rule*
56 FR 3600	30 January 1991	*Proposed Revisions to VOCs Monitoring Requirements: Reproposed MCLGs and MCLs for 5 SOCs*
55 FR 30370	25 July 1990	*SOCs and IOCs (Phase V) Proposed Rule*
54 FR 22062	22 May 1989	*SOCs and IOCs (Phase II) Proposed Rule*

Lead and Copper

53 FR 31516	7 June 1991	*Lead and Copper Rule*
54 FR 14320	10 April 1989	*Proposed List of Non-Lead-Free-Coolers*

ABBREVIATIONS AND ACRONYMS

AOC	assimilable organic carbon
ANPR	Advance Notice of Proposed Rulemaking
AWWA	American Water Works Association
BAT	best available technology
DEH	Directorate of Engineering and Housing
CFR	Code of Federal Regulations
CWS	community water system
D/DBP	Disinfection/Disinfection Byproducts Rule
E. coli	Esclerichia coli
EDB	ethelyne dibromide
EPA	U.S. Environmental Protection Agency (used in mandatory language for public notice)
FR	Federal Register
GAC	granular activated carbon
GC	gas chromatography
GC/MS	gas chromatography/mass spectrophotometry
gpm	gallons per minute
GWDR	Groundwater Disinfection Rule
HEX	hexachlorocyclopentadiene
HPC	heterotrophic plate count
IOC	inorganic chemicals
MCLG	Maximum Contaminant Level Goal
MCL	Maximum Contaminant Level
MGD	million gallons per day
MX	3 chloro 4-(dichloro methyl)-5-hydroxy-2 (5H) furanone

NCNTWS	noncommunity nontransient water system
NCTWS	noncommunity transient water system
NIPDWR	National Interim Primary Drinking Water Regulations
NTV	nephelometric turbidity unitave
P-A	presence-absence
PAC	powered activated carbon
PCB	pdychlorinated biphenyl
ppm	parts per million
PWS	public water system
PWSS	public water system supervisor
RMCL	Recommended Maximum Contaminant Level
SMCL	Secondary Maximum Contaminant Level
SDWA	Safe Drinking Water Act
SWTR	Surface Water Treatment Rule
SOC	synthetic organic chemical
TCE	trichlorethylene
TCR	Total Coliform Rule
THM	trihalomethane
TTHM	total trihalomethane
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic chemical
WHPP	Wellhead Protection Program
WHPA	Wellhead Protection Area

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